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ABSTRACT

The new style curriculum guidelines for industrial education courses in Canada are published in this book and are designed to be used in conjunction with supporting materials distributed by the Provincial Industrial Education Resource Centre. The introduction includes a description of the guide and explains this new approach to secondary industrial education. The program's organization and goals are discussed, as well as the expectations of students and teachers. The advanced studies programs for particular occupations are surveyed also. Subject areas in the guide are drafting, woodwork/construction, metal, mechanics, electricity/electronics, and technology. Each section contains introductory statements, a general outline, intended learning outcomes, and a sample model (one approach to meeting the intended learning outcomes for a particular subject area). (CT)

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ED170553

da Vinci's Man: Universal symbol serving as an example of the technological capabilities, achievements and creative potential of mankind.

Province of British Columbia
Ministry of Education
Schools Department
Curriculum Development Branch

Secondary School Curriculum Guide
Industrial Education

CE 020 762

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
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GLOSSARY

It is important that the reader places the correct interpretation on the terminology used in this guide, and this glossary is included for this purpose.

A - The first course (100 + hours) taken; e.g., I.E. 9/10A, Cst. 11A, Mx. 12A.

B - The second course (100 + hours) taken; e.g. I.E. 9/10B, Cst. 11B, Mx. 12B.

C - The third course (100 + hours) taken; e.g. I.E. 9/10C, Cst. 11C, Mx. 12C.

BASIC - Topics and operations which must be taught.

COMPONENT - All or part of a course, as plastics in Construction 12; as woodwork in I.E. 8.

COMPONENT TITLES - woodwork, metalwork, house construction, etc.,
Note: Component titles begin with a lower-case letter.

COURSE - A full year or full semester set of studies (100 + hours).

COURSE TITLES - I.E. 8, I.E. 9/10A, Cst. 11A, etc..
Note: Course titles begin with an upper-case letter.

GOALS - Objects of the students' efforts or ambitions.

GUIDELINES - Introductory statements and general notes in subject sections.

LEARNING OUTCOMES - The end product of the skills and knowledge that must be taught.

LEVEL - Appropriate degree of achievement.

MODEL - An approach to instructional materials design that will serve as an example.

OBJECTIVE - The end product of the steps in a particular subject field.

OPTIONAL - Topics and operations which may be taught.

PROGRAM - A selection and arrangement of courses in Industrial Education.

RESOURCE CENTRE - The centralization of I.E. subject matter materials; e.g., Provincial Resource Centre and District Resource Centre.

RESOURCE COMMITTEE - Representatives from B.C. Shop Teachers' Association; Division of Industrial Education, U.B.C.; and Ministry of Education authorized to screen resource materials.

SAMPLE OUTLINE - Suggested pattern of topics and operations, plus related knowledge.

SI - International System of Units - name given to the most recent version of the metric system.

SUBJECT ADVISORY COMMITTEES - On-going members of the Revision Committee nominated by the B.C.T.F. and ratified by the Ministry of Education.

SUBJECT SECTION - One of the six major subject areas; e.g., Mechanics.

SUPPLEMENTAL - Topics and operations which should be taught.

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INTRODUCTION

1.1 Preamble

The Industrial Education program is divided into six main subject sections of Drafting, Wood/Construction, Metal, Mechanics, Electricity/Electronics, and Technology. Each subject section contains courses, and each course is made up of component parts.

1.2 Features of the Program

1.2.1 General

The move towards local interpretation of curriculum recommendations was a major influence on the thinking of the participants in the workshop sessions. There was agreement that the central authority had a responsibility to outline general guidelines for the program and to indicate learning outcomes to be achieved. However, it was felt that the work of expanding and refining the learning outcomes outlined, developing appropriate teaching strategies and evaluation techniques were local responsibilities.

1.2.2 Specific

The major feature of this guide is the change in the organization and recording of courses in the Industrial Education program. This change, outlined in Section 2, has been made to provide schools with an increased degree of flexibility in providing for individual student needs and, therefore, is compatible with local decision making.

Other features include the separation of Metal and Mechanics, the replacement of the Industrial Power/Industrial Science sequence with Technology courses, and the inclusion of plastics as a component part of Construction courses.

1.2.3 Format

Each subject section presents a set of objectives and learning outcomes. Each section is organized by levels that correspond, in general, with the grades for which the learning outcomes are felt to be appropriate.

Some sections are more detailed than others. In general, greater detail is provided where significant changes from the previous content or approach have been made.

1.3 Implementation

Effective September 1977 this guide will be the prescribed program.

1.4 Textbooks

Textbooks prescribed to support Provincial courses are listed in the **Prescribed Textbook List** published annually by the Publication Services Branch of the Ministry.

The work of identifying suitable texts for this program has been completed, and these texts will be published in the metric (SI) system of measurement. As metric editions of suitable reference books are identified, they will be listed in the **Prescribed Textbook List.**

1.5 Resource Centre and Resource Materials

Concurrently with the release of this 1977 Curriculum Guide, the Ministry has established the Provincial Industrial Education Resource Centre at 3750 Willingdon Avenue, Burnaby. The centre is located in the same building as the Industrial Education Teacher Training Program. There is a continuing association with the U.B.C. faculty and the British Columbia Shop Teachers' Association of the British Columbia Teachers' Federation.

An apparent need, identified by the workshop participants and supported by practising I.E. teachers, is for resource information which will identify lists of equipment, suppliers, reference materials, projects, teaching strategies, etc.. Such publications will be recommended by the Resource Committee. The centre will concentrate on original materials only, and as these materials are published, school district resource centres will receive one copy for reproduction purposes. The development of suitable materials will depend largely on the cooperation of practising I.E. teachers in sharing ideas and teaching successes.

In this distribution seven sections will be identified by the same emblems used to divide the guide into Drafting, Wood/Construction, Metal Mechanics, Electricity/Electronics, and Technology. The main cover design will identify the seventh section for general materials.

1.6 Safety

Safety is a major concern in any subject area which features "hands on" experience by students. Particular attention should be given to the third goal as listed in the section headed "Program Goals for Industrial Education":

> 3.3 *To develop in the students a high degree of safety consciousness.*

This goal must represent the primary aim of every Industrial Education course.

2. ORGANIZATION OF THE INDUSTRIAL EDUCATION PROGRAM

2.1 General

The organization presented here allows for local interpretation and implementation. The guidelines and learning outcomes for the program are indicated, while the organization of the learning outcomes into courses and the number of courses to be developed and offered are left to local decision.Any program organization generates information in the form of records.
At the Provincial level, certain information regarding numbers of students taking courses in the various programs is required. At the local level, more specific information regarding courses taken is needed. The organization outlined indicates the format for necessary records.

The organization is outlined separately for junior secondary and senior secondary. It is important to note, however, that the organization suggests a continuity of learning. Hence, the importance of communication at the local level between junior and senior secondary schools must be stressed.

2.2 The Junior Secondary School — Grades 8, 9, 10

2.2.1 Industrial Education 8

The organization of Industrial Education 8 is designed to meet the exploratory and preparatory functions of the total junior secondary school curriculum. It is expected that the I.E. 8 course will provide students with exploratory experiences in the four basic components of drafting, woodwork, metalwork and electricity. For both official record purposes and local reporting purposes the course will be referred to as Industrial Education 8 (I.E. 8).

2.2.2 Industrial Education 9/10

The organization of Industrial Education 9/10 identifies guidelines and learning outcomes for each of the component parts. These components are:

drafting
woodwork
metalwork
mechanics
electronics

Course content is based upon learning outcomes outlined in one component part, or upon a combination of learning outcomes outlined in two or more component parts. Therefore, a component may be all or part of a course.

Note: A course is considered to be a full year or full semester set of studies (100 + hours).

The implementation of courses and the decision as to the number of courses to be offered are seen as school responsibilities.

For official record purposes (Permanent Record Cards, Form K, etc.) any courses designed should be referred to as Industrial Education 9/10 (I.E. 9/10). The number of courses taken by a student should be indicated after the course designation by using the uppercase letters A, B, C, etc.. For example, a student taking three Industrial Education courses at the Grade 9 and/or 10 level should have these courses recorded as I.E. 9/10A, I.E. 9/10B, I.E. 9/10C.

Please remember that "A" = 100 + hours, "B" = an additional 100 + hours, and "C" = a third 100 + hours. The suffixes A, B, C, etc., are time factors and have no bearing on actual course content.

For local reporting purposes (student report cards, etc.), each course must be identified by the use of a suitable term in parentheses following the official course designation.

Examples: I.E. 9/10 (woodwork)
I.E. 9/10 (drafting and woodwork)
I.E. 9/10 (mechanics and metal)
I.E. 9/10 (electronics)

Each of these examples represents 100 + hours.

Note: A, B, C, etc., must be reserved for the Permanent Record Card.

In making decisions as to the number of courses to be offered and the components to be included in these courses, a number of factors need to be considered, such as:

a) the perceived needs of the students;
b) the human and physical resources available;
c) the components available at the senior secondary level.

2.2.3 Summary

Industrial Education in the junior secondary school is structured as follows:

Program: Industrial Education

Courses (P.R. Card designation)	**Components (Local designation)**
	Mandatory:
I.E. 8	drafting woodwork metalwork electricity
	Optional:
I.E. 9/10	drafting woodwork metalwork mechanics electronics

2.3 The Senior Secondary School — Grades 11 and 12

The organization of Industrial Education 11/12 has no Provincial pre-requisites for entry into 11 level courses. However, before enrolling in a 12 level course, a student will have completed an appropriate 11 level course. The Provincially identified guidelines and learning outcomes for the major courses in the program are outlined in the guide. The development of each course becomes the responsibility of the school operating within district policies.

The following have been identified as the major courses in the Industrial Education program at the senior level:

Drafting
Construction
Metal
Mechanics
Electronics
Technology

The component parts of these courses are numerous; e.g., house construction, cabinet making, welding, electricity, forestry, etc..

Schools will continue to offer, in one or more of the component parts, 11 and 12 level courses. However, the number of courses and components to be offered is seen to be a school responsibility. In other words, schools may decide to offer one or more 11 and 12 courses with component parts of the courses based upon the guidelines and learning outcomes identified. If, for example, one 11 level course in Construction is to be offered, it should be recorded for official record purposes (Permanent Record Cards, Form K, etc.) as Cst 11A. If more than one course is to be offered at this level, they should be denoted as Cst 11A, Cst 11B, etc.. For example, a student taking three Mechanics courses at the Grade 11 level should have those courses recorded as Mx 11A, Mx 11B, Mx 11C.

Please remember that "A" = 100 + hours, "B" = an additional 100 + hours, and "C" = a third 100 + hours. The suffixes A, B, C, etc., are time factors.

For local reporting purposes, each course should be identified by the use of a suitable term in parentheses following the official course designation.

Examples: Cst 12 (cabinet making)
Cst 12 (house construction)
Cst 12 (plastics)

Each of these examples represents 100 + hours taken in a full year or a full semester set of studies.

Note: A, B, C, etc., must be reserved for the Permanent Record Card.

2.3.1 Summary

Industrial Education in the senior secondary school is structured as follows:

Program: Industrial Education

Courses (P.R. Card designation)		Components (Local designation)
Drafting 11 — Drf 11 Drafting 12 — Drf 12	(Use A, B, etc.)	architectural mechanical and others
Construction 11 — Cst 11 Construction 12 — Cst 12	(Use A, B, etc.)	furniture making building construction plastics, and others
Metal 11 — Mtl 11 Metal 12 — Mtl 12	(Use A, B, etc.)	machine shop metal fabrication and others
Mechanics 11 — Mx 11 Mechanics 12 — Mx 12	(Use A, B, etc.)	auto maintenance car care and others
Electronics 11 — Elx 11 Electronics 12 — Elx 12	(Use A, B, etc.)	basic electronics, audio, electricity, digital, RF, and others
Technology 11 — Tech 11 Technology 12 — Tech 12	(Use A, B, etc.)	mechanical engineering aeronautics and others

3. PROGRAM GOALS FOR INDUSTRIAL EDUCATION

3.1 To develop interests in the technical fields and applied sciences as an integral part of the students' general education.

3.2 To develop a foundation of skills and knowledge related to materials and technical procedures.

3.3 To develop a high degree of safety consciousness.

3.4 To develop confidence, high standards of performance, and a sense of pride in achievement.

3.5 To develop creative potential both avocationally and vocationally.

3.6 To achieve a degree of competency that will assist students to obtain further education, training, or employment.

3.7 To develop an insight into the workings of the industrial world.

4. EXPECTATIONS OF STUDENTS AND TEACHERS

4.1 General

Industrial Education for boys and girls is an integral part of the comprehensive school system and is designed with two major objectives:

a) Experience in practical courses as part of general education

b) Preparation for direct entry into employment.

In addition to these two major objectives, Industrial Education should develop in students:

a) An appreciation of the dignity of craftsmanship and a pride in a high level of achievement.

b) The ability to practise correct English, applied mathematics and technical reading.

4.2 Students

4.2.1 *Written English* — Written reports in composition form should be required. Sentence and paragraph structure should be complete. Teachers of Industrial Education will identify errors in punctuation, spelling, sentence structure, etc.. Students must be trained to correct errors. All Industrial Education teachers have a responsibility to teach students the skills of writing appropriate to their field.

4.2.2 *Reading* — Industrial Education teachers should check the students' ability to read technical terms and in particular statements and warnings relating to safety. Technical reading requires accurate interpretation. Accurate interpretation rather than speed is essential. Required reading for students should not be assigned until the content and related materials have been discussed. Before entering industry, students should be competent in reading technical data and be able to cross-reference technical terms and model numbers. All Industrial Education teachers have a responsibility to teach students the skills of reading appropriate to their field.

4.2.3 *Applied Mathematics* — Calculations, measurement and pricing are all part of I.E. courses. Most students readily implement mathematical functions when constructing a project or completing an exercise. The need for mathematical accuracy becomes more apparent to students when related to solid objects.

4.2.4 *Evaluation of Achievement* — In evaluating we often reward students for not making mistakes and penalize those who do. In many Industrial Education courses mistakes are obvious to the students and teachers and they become positive learning experiences. The following points must be considered in evaluation:

a) When ranking, quality is important but the time taken to complete a task must also be taken into consideration.

b) In practical courses mastery is essential; e.g., if an eight cylinder engine fires on seven, this would represent 87½%, but could not in any way be considered satisfactory. Near perfection is required in most I.E. courses, and teachers should expect a high standard of achievement.

c) Work habits, attitudes, use and care of equipment must all be assessed.

d) Basic skills, particulary hand skills, should be assessed to establish mastery at the appropriate level. The use of hand tools, and in particular the sharpening of such tools, is basic to all advanced work in Industrial Education.

e) Evaluation check lists should be established; e.g., correct procedure for adjusting and operating a router.

f) When assessing student work at the senior level, achievement should be compared with current industrial quality.

g) In developing questions for tests or examinations, simply asking for memorized information is not sufficient. Emphasis should be given to unseen "problems" which call for thinking as well as the application of knowledge and skill.

h) Objective testing is particularly valuable in assessing the work of students in I.E. courses.

i) All assessment in practical courses should be cumulative; i.e., throughout a course a number of operations and skills should be assessed leading to a final result.

4.3 Safety

The nature of Industrial Education requires that correct safety practices be established as soon as students commence their studies. It is the responsibility of the teacher to ensure that all students are aware of hazards in shops and that established procedures are followed. It must be emphasized that safety education is a continuing experience. Teachers must use good judgement when instructing students in safety practices, and it must be remembered that the main objective is education.

4.4 Teachers

4.4.1 *Student Admission to Courses* -- Grade 8 Industrial Education or Home Economics is mandatory for all students. From Grade 9 onward students elect courses in I.E.. Where there is an oversubscription to I.E. courses, the following criteria, in order of priority, must be considered for student admission (boys or girls):

a) The course is mandatory for the student to meet graduation requirements.

b) The course is desirable as one of the optional courses to meet graduation requirements.

c) The course is requested for general interest or avocational purposes.

Further to the above priorities and to a later statement on career counselling, a student who has been admitted to junior courses with an understanding that senior courses will be available in Grades 11 and 12 must be given absolute priority. This does not mean that it is mandatory on the student's part to enter a senior course.

4.4.2 *Evaluating Courses* — From time to time each teacher should assess his or her courses. Points to consider should be:

a) Level of achievement for the particular grade.

b) Success of graduates, both in post-secondary courses and in finding employment.

c) Methods being used in courses as compared to those in modern industry.

d) Mastery of course content and the confidence displayed by students at the end of the course period.

e) Creativity developed in students by sufficiently challenging course content and standards.

f) Effectiveness of related reading, writing and mathematics.

4.4.3 *Career Counselling* — Shop teachers are in a unique position to give advice to students on appropriate careers in industry. This advice should be on a one to one basis. The teacher's background can be invaluable in that he may be able to identify a student with an aptitude and interest in a particular occupation. Industrial Education teachers should advise students, particularly at the Grade 9/10 level, on the availability of senior courses. It is at the junior level that a student often finds success in a particular area of study. However, the teacher should not be too specific, but should encourage preparation for a general career in the mechanical, construction, service or appropriate industries.

All I.E. teachers should be familiar with the college and vocational programs available to students.

4.4.4 *Liaison with Industry* — It is the responsibility of all I.E. teachers to keep up to date with industrial and technological developments and to adjust their programs accordingly. Unfortunately schools are not visited frequently by representatives from industry. The onus is on the teacher to go to industry and, where applicable, take his students. I.E. courses should reflect modern industry rather than the most recent textbook which could be at least five years out of date. It is most important that when a student leaves the secondary school he is confident and able to succeed in the next training institution or in a job. Practical experiences in I.E. courses should develop the necessary characteristics for this success; e.g., good attitude; reliability, accuracy and pride of achievement; ability to follow directions; ability to communicate clearly; capacity to work with others.

4.4.5 *Industrial Advances and Consequent Relationship with Industrial Education Courses* — The new technology courses are designed to provide an opportunity for teachers to develop courses with emphasis on the most up-to-date techniques, materials, scientific principles and applications found in industry.

Most large production plants and buildings are created and operated by a combination of architects and civil, electrical and mechanical engineers. The employees are more likely to be technicians than craftsmen, and all of these employment opportunities should be better understood by the students who will be entering the work force in the eighties.

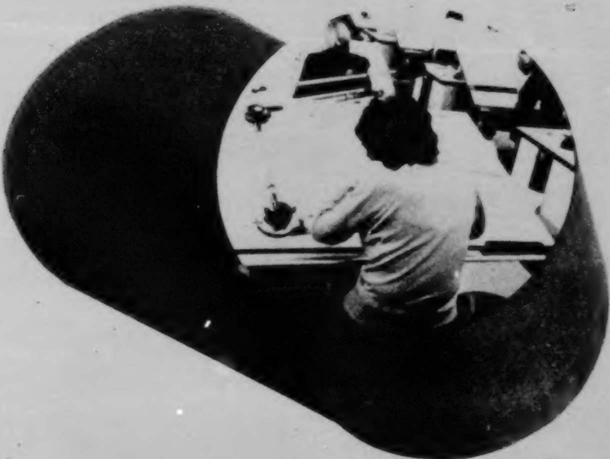
5. PROGRAMS FOR PARTICULAR OCCUPATIONS (ADVANCED STUDIES)

5.1 General

These programs may only be offered with Ministry of Education approval. They are designed for students wishing to spend fifty percent of their time in a particular subject area such as automotive, carpentry, machine shop, et al. Successful completion of an advanced studies program may allow a student to enter directly into the second stage of a post-secondary program in that specialty. Teachers offering advanced studies must be familiar with appropriate post-secondary training and careers in industry in order to articulate with the total program.

Section 4, "Expectations of Students and Teachers", also applies to Programs for Particular Occupations (advanced studies.) The curriculum outlines to be used for Programs for Particular Occupations (advanced studies) should be those used in the first stage of the appropriate specialty in a post-secondary institution. These outlines are obtainable from the Ministry of Labour and/or a post-secondary institution.

DRAFTING



6 DRAFTING

6.1 Introductory Statements

6.1.1 Drafting is broadly defined as an area of study that provides for continuing development of student ability in visual communication.

6.1.2 Suitable student activities may be selected from the general outline (6.2). The introduction of other concepts and practices is encouraged. Photographic and reprographic processes may be explored. For more detailed information in Graphic Communications refer to the appropriate curriculum guide.

6.1.3 The learning outcomes listed are suitable for each of the levels. The degree of difficulty at which the learning outcomes are presented will vary according to student ability. Project oriented problems and drawings should be included.

6.1.4 It is not the intention of this guide to limit the imagination and industry of students and teachers, but rather to encourage the introduction of interesting modern practices.

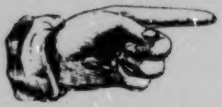
6.2 General Outline

6.2.1 Learning outcomes in drafting include shape, size, finish, colour and motion.

6.2.2 Materials for exploration in drafting include paper, pencil, ink, stencils, film, plates, transparencies, tapes and reprographics. Selection of alternative media should be compatible with the students' interests and abilities.

6.2.3 The students' degree of growth in achieving visual communication skills must be assessed by regular evaluation.

6.3 I.E. 8 - drafting



Intended Learning Outcomes

Upon completion, the student should be competent and confident in the application of the following:

6.3.1 Basic

SHAPE

- modelling — clay, plasticine and paper.
- sketching — pictorial, one and two views.
- drawing — with instruments including three views, titles and notations, simple projects.
- designing — functional projects, basic proportion.

SIZE

- measuring — imperial and metric, scaling.
- dimensioning — unidirectional preferred.

6.3.2 Supplemental

FINISH

- using symbols and notations.

COLOUR

- using colour effectively.

BASIC

Topic or Operation	**Related Knowledge**	**Notes**
1. Introduction	Description of equipment Types of set square Grades of pencils	
2. Lettering	Gothic Sloping or vertical	Sloping or vertical lettering, but consistent on any one drawing. Done with H pencil, once over. Large - 5 mm; Small - 3 mm. Use of guide lines required for uniform size. **No** lower-case letters.
3. Lines		
Quality	Circles, arcs, curves Sloping lines Horizontal lines, top to bottom Vertical lines, left to right	
Darkening in Procedure	Pencils H, 3H Procedure must be stressed - first faint with 3H for guide lines and construction lines Before darkening in, construction must be initialled Unneeded construction lines may be erased before darkening in Centre lines	Rotate pencil for uniform line weight.
Types of Lines	Outline, hidden, centre, section, cutting plane, extension, dimension and leader	
Line Weight	Stress the contrast between different lines. Cutting plane)) Outline (body)) Bold) H Hidden line Medium) Centre, section) Dimension, extension) Fine 3H	
4. Sketching	Stress proportion rather than exact size.	
Aids	Aids may be used, but no measuring	
Techniques	Straight lines — sighting — straight edges Circles — paper with radius mark Ellipses — see geom. construction Stress neatness, line weight	

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BASIC

Topic or Operation	Related Knowledge	Notes
5. Geometric Construction	Drawings or exercises to include the following: Bisecting an angle Perpendicular bisector Dividing a line into 3 or more equal parts Constructing a hexagon — inside a circle — outside a circle Drawing a tangent	
6. Orthographic Projection *Theory*	Explanation of name Names of views (top, front, L & R sides) Position of views Use of projection box to show origin of views, lines, etc. Use of hidden lines	

Orthographic Procedure	Determine how many and which views are to be drawn
	Determine scale to be used and size of paper
	Align and fasten paper
	Faint blocking in of views (trial and error) (suggested 30 to 40 mm. between views when dimensioning is required)
	Transfer depth dimensions from top to side view by ruler or compass
	Add details (light)
	Erase construction and projection lines
	Get initialled
	Darken in lines (follow procedure section 3)
	Add extension and dimension lines (10 mm. increments)
	Add numbers, arrowheads
	Add notations, lettering	

7. Isometric Drawings *Theory*	3 dimensional Single view Explanation of term isometric Discussion of isometric axes Discussion of envelopes Type of lines — isometric, non-isometric, curved, circles	Hidden lines normally omitted

BASIC

Topic or Operation	**Related Knowledge**	**Notes**
Isometric Procedures	Study object. Determine basic shape of envelope Decide on scale Determine where starting point should be in order to centre drawing Locate point and draw in 3 axes Complete the envelope according to overall dimensions Add details lightly, inside the envelope Erase construction lines (if desired) Get initialled Darken in, following the lining-in procedure Add any dimensions Add notations, title strip, lettering	
Dimensioning	Terms — extension, dimension, leader notation Line weight — 3H — Fine Space increments 10 mm. Arrowheads — size — type — (consistent) Finish marks Principles to be followed as per S.I. Standards (Uni-directional)	Some basic exercises may be given for practice, but real objects should be used where possible.
8. Sectioning	Reasons for sectioning Types of sections — full section — half section — revolved section Basic symbols, e.g., wood (flat, edge, end); mild steel, iron Line weight Treatment of adjacent sections — slope, spacing	

SUPPLEMENTAL

Topic or Operation	**Related Knowledge**	**Notes**
9. Rendering *Shading*	Soft pencil Light & dark parts of the object	
Colouring	Water colours Pastels	

6.4 I.E. 9/10 - drafting

Intended Learning Outcomes

Upon completion, the student should be competent and confident in the application of the following:

6.4.1 Basic

SHAPE

- modelling — irregular shapes, laying out and cutting patterns of parallel and radial line developments.
- sketching — pictorial, orthographic, auxiliary views and sections.
- drawing — orthographic, pictorial, detail, assembly, geometric problems, sheet metal developments, architectural, appropriate titles and notations, fastenings and threads.
- designing — objects which exhibit realistic proportion in a variety of style and function.

SIZE

- measuring — with precision instruments.
- dimensioning — sketches and drawing to C.S.A. standards.

FINISH

- symbols and notations.

6.4.2 Supplemental

COLOUR

- applying colour to enhance projects.

MOTION

- indicating alternative positions.

BASIC

Topic or Operation	Related Knowledge	Notes
1. Graphic Language	History of, Advantages of, Universal Terminology	
2. Standards	Reason for, C.S.A. and A.N.S. Class procedures	
3. Working Area	Lighting, noise, movement Clean, care, and accuracy	
4. Drawing Materials	Advantages and limits of paper, tracing paper, velum tracing linen, plastics, such as mylar and acetate	
5. Tools	Pencils and inking pens	
6. Drafting Equipment	Use and care of all the basic drafting equipment Precision drawing instruments	
7. Measurements	Use of scale Fractional inch system Decimal inch system Metric system Full scale, reduced scale and enlarged scale drawings Measuring angles	
8. Symbols & Lettering	Alphabet of lines Freehand lettering Use of lettering machines	
9. Geometric Construction		
Uses in Technical Drawing	Shortcuts and increases, accuracy	
Straight Lines	Use of straight edge, T square set square to draw horizontal, vertical, parallel lines. To bisect and divide lines and angles into a number of parts.	

Topic or Operation	Related Knowledge	Notes
Circles & Arcs	Use of compass and how to draw accurate circles, arcs and tangents As the basis for plain figures such as the square, octagon, hexagon and pentagon.	
Ellipses	True ellipses using the trammel and concentric circle methods	
10. Shape Description		
Methods of Describing	Freehand drawing, sketch and mechanical drawing	
Types of Descriptions	Advantages and disadvantages of pictorial drawing and orthographic projection.	
11. Orthographic Projection	Related position, selection and projection of views Steps in producing orthographic drawings Reading orthographic drawings	
12. Section Views	Understanding and use of cutting plane and section lines Knowledge of full, half, off-set, broken out, revolved and removed sections Conventional breaks Revolving features such as ribs and spokes	
13. Auxiliary Views	Purpose of Projection of inclined surfaces Reference planes, and identification numbers Use of auxiliary views in order to complete regular views.	
14. Fastening Devices		
Screw Threads	Principle of threads Thread forms Thread representation by pictorial or semi-conventional drawing Schematic or conventional drawing Simplified thread symbols Drawing of common thread fastening devices such as the hex. head and square head nut and bolt	
Other Fastening Devices	Other fastening devices such as rivets, washers, keys and pins	

BASIC

Topic or Operation	Related Knowledge	Notes
15. Symbols and Conventions	Extension, dimension and leader lines Arrowheads and dimension figures Notations and abbreviations	
16. Dimensioning Theory	How; what and where to place dimensions Dimensioning of rectangles, angles, circles and arcs Size or location dimensions Uni-directional and aligned methods of dimensioning	
17. Units of Measurement	Fractional inch system Feet and inch system Decimal system Metric system	
18. Additional Dimensioning	Information covering tolerances, allowances and machining symbols such as finishing marks	
19. Working Drawings		
Title Blocks	Information needed to complete the drawing such as title, parts list, part numbers and bill of materials.	
Reading Drawing	Interpreting or finding information from drawings produced by others	
Simplified Drafting	Time and cost saving methods such as elimination of views, simplified symbols, simplified dimensions and the use of templates	
Shop Processes	An understanding of the various methods used in the manufacturing processes	
Detail Drawings	Correct selection of the views and dimensions required to describe each individual part	
Assembly Drawings	A description of the total object and the relationship of the individual parts Dimensioning assembly drawings Use of section views Outline assembly drawings Detailed assembly drawings where individual and total descriptions are included on the views of simpler objects	

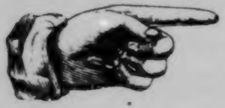
BASIC

Topic or Operation	Related Knowledge	Notes
Designing	Problem solving by designing shapes which are both functional and pleasing	
20. Pictorial Drawing		
Type of Pictorials	Overcome the problem of drawing a 3 dimensional object on a 2 dimensional surface by perspective, isometric or oblique system	
Isometric Projection	Isometric axes Box construction Isometric lines, non-isometric lines Measuring on isometric lines Circles and arcs in isometric using the 4 centre method of constructing an ellipse or template Irregular curved lines drawn in isometric by plotting points on a grid Sectioning in isometric drawings	
Oblique Drawing	Shading on isometric drawings Oblique axes Box and skeleton methods Depth axes angle and scale Cavalier and cabinet systems Angles in oblique Circles and arcs in oblique Sectioning, shading and dimensioning oblique drawings	
	SUPPLEMENTAL	
21. Pattern Development		
Types of Developments	Straight line Parallel line Radial line Lines used for pattern developments	
Straight Line Development	Unfolding or stretchout of rectangular shapes Transfer of sizes by stepping off Use of identification numbers Types of seams and edges and their allowances	
Parallel Line Development	Unfolding or stretch-out of cylindrical objects Circumference by calculation and stepping off method Use of elements and identification numbers Length and height intersections for truncated cylinder development Seam and edge allowances	

Topic or Operation	Related Knowledge	Notes
Radial Line Development	Unfolding or stretch-out of a cone or pyramid Circumference and slant height Calculation or step-off method of finding circumference Element and identification numbers Seam and edge allowances Finding the true length of lines for the pattern development of pyramids	
Intersections	Intersections of a line and a solid Intersection of flat surfaces such as prisms Intersection of cylinders	
22. Architectural Drawing		
House Types	Advantages and disadvantages of the basic house types Cost factor and other limits	
Developing The Plan	Developing or selecting a suitable floor plan Room requirements and sizes Travel areas such as halls and stairways	
Architectural Symbols	Planning, placement and drawing of door symbols Planning, placement and drawing of window symbols Planning, placement and drawing of fireplace, plumbing fixtures and kitchen furnishings Planning, placement and drawing of electrical fixtures	
Exterior Appearance	Projection and drawing of the front elevation Roof types Exterior finishes	
Habitability	Checklist of home function Is plan of house functional?	

Topic or Operation	Related Knowledge	Notes
23. Survey of Drafting Fields		
Drafting as a Vocation	Various fields of drafting work such as topographic, architectural, structural and marine drafting Related vocations such as surveying, engineering or designing	
Drafting and Industry	Examine the function of a drawing from the drafting office, checking, reproduction of, to shop areas and assembly	
24. Rendering		
Shading	Soft pencil Light & dark parts of the object Shadows Texture	
Colouring	Water colours Pastels Shadows Texture	
	Supplemental Refer to Page 26. Section 6.4.2	

6.5 Drafting 11 and Drafting 12



Intended Learning Outcomes

Upon completion the student should have expanded his or her abilities in the applications of the following:

6.5.1 Basic

SHAPE

- modelling — cardboard or wooden architectural models, paper cut-outs of transition development, wooden mock-ups of compound revolutions and scale models of design problems.
- sketching — exploded pictorial, design problems in various materials.
- drawing — geometric problems, orthographic projections using instruments, drafting machines and parallel rules, pictorial views, perspective, detail and assembly, auxiliary views, sections, compound revolutions, sheet metal intersections, transitions, architectural, welding and electrical diagrams, mapping and navigation, graphs, fastening, threads.
- designing — practical problems requiring individual creative solutions.

SIZE

- measuring — precision instruments, fits, limits, tolerances, gauges, datum lines.
- dimensioning — unidirectional preferred, in accordance with C.S.A. and SI standards, architectural styles.

FINISH

- symbols and notations for surface preparation.

COLOUR

- industrial finishes to preserve and enhance the project.

MOTION

- gears, cams and followers including displacement diagrams.

BASIC

Topic or Operation	Related Knowledge	Notes
1. Introduction	Brief reminder of instruments, pencils, cleanliness, etc. List course objectives and areas to be covered. Commence at least two plates on geometrical construction illustrating tangents, curve to curve connections, reverse curves, etc.	
2. Sketching	Review of orthographic projection. Sketch three view drawings on squared paper from oblique and isometric diagrams. Make solid models from wood to assist in visualization. Vary difficulty to match student's ability. Sketch isometric views from orthographic drawings using isometric graph paper through to non-isometric lines and irregular shapes. Sketch oblique views from orthographic drawings using squared paper. Carry through to irregular shapes including reverse angles. Sketch Cavalier and Cabinet styles for comparison.	
3. Instrument Drawings	(Including use of Drafting Machines and Parallel Straight Edges if available). One view objects — stress neat accurate line work — first with straight lines then with arcs and circles. Calculate for locating drawing on paper. Two view drawings — location and choice of views — position of object. Three view drawings (orthographic projection) position of object, spacing — develop all views simultaneously.	

BASIC

Topic or Operation	Related Knowledge	Notes
4. Dimensioning	Review of basic dimensioning — note new methods, 10 mm. increment, unidirectional system, SI standards, etc. Leading to three view drawings with dimensions. Precision measuring, use of datum line, reference line, tolerance, limit system, fits, clearance and gauges. Surface characteristics, texture, roughness, decoration, etc.	
5. Fastening Devices Thread Forms	Unified and Metric symbols. SI simplified representation — class of fit — nuts, bolts, rivets, screws, keyways, etc.	
6. Section Views	Cutting plane lines — section lines, symbols, full section, half section, offset section, broken out section, revolved section — conventions for fasteners, lugs, ribs, etc., break symbols.	
7. Auxiliary Views	Vertical reference plane, horizontal reference plane, centre plane reference, perpendicular to inclined surface, secondary auxiliary plane.	
8. Working Drawings	Complete working drawing of individually selected problem. Could be a metalwork or woodwork project or any mechanical device.	
9. Pictorial Drawing	Exploded isometric of all or part of previous drawing showing assembly sequence. Trace and print this drawing to illustrate quality of line work. Expand oblique drawings to include irregular shapes, reverse angles, cabinet and oblique.	

Topic or Operation	Related Knowledge	Notes
10. Surface Development and Intersections	Parallel line development — rectangular objects, circular objects, use cardboard examples. Reverse patterns on elbows to save material. Cut out the patterns with scissors and assemble with masking tape to check accuracy and fit. Radial line development, truncated cone, pyramid, oblique pyramid. True length diagrams. Transitions — square to round, rectangular to round, rectangular to round offset, etc. Intersections — cylinders at right angles, cylinders at any angle. Various prisms at 90° and other angles.	
11. Architectural Drawing	Limit the choice to a simple structure in Drafting 11 so that the student will have time in Drafting 12 to develop a full set of drawings for his own house design in Drafting 12. Recreational homes without basement such as summer cabin, winter cabin, garage, workshop, hunting lodge, boat house, ski shack. All individual designs permit use of "A" Frame, but still remain within time allotment of 6 to 8 weeks. Use "Drafting Fundamentals" as text. Introduction — Floor plans, symbols, templates, scales. (Use 1/4" = 1'0" until Metric Arch is established). Locate common symbols on a semi-prepared floor plan. Develop the shape of the building from a list of requirements. Make up a list of desirable features that the building should contain, then use these areas in very rough elliptical areas to fit them together and eventually evolve a plan. Develop a floor plan as a line diagram to settle room sizes taking into	

Topic or Operation	Related Knowledge	Notes
	account traffic patterns, furniture sizes, cupboards, storage areas, stairs, etc. Expand the line diagram on 1/4" squared paper, allow 6" for wall thickness and arrive at the final size of the building. Draw the completed floor plan at 1/4" = 1'0" (at present) include plumbing fixtures, electric wiring, inside and outside dimensions. The foundation plan will have to suit the location and may be concrete wall, concrete block, cedar posts, beams, skids, etc. Front and side elevations as time permits. Section through exterior wall.	

BASIC

Much of the Drafting 12 course should be on an individual assignment basis. Once the area has been reviewed, then the student should become involved in a problem solving situation which in many cases can be related to projects that are being developed in other shops. The Architectural portion of the course will require 3 to 4 months, but other areas should not be neglected.

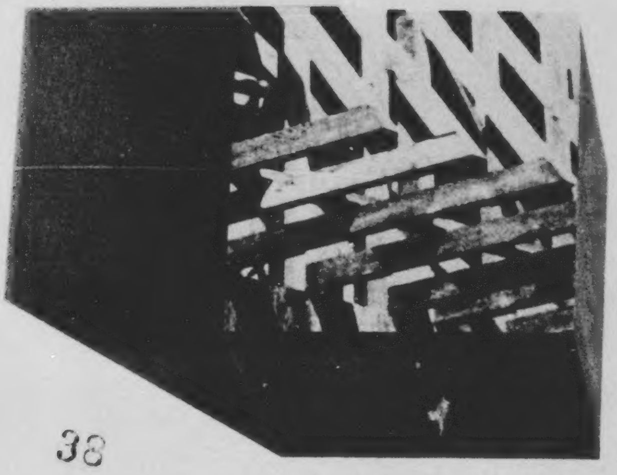
Topic or Operation	Related Knowledge	Notes
1. Geometry		
Cams	The radial ignition diagram from an Automotive Text provides a base for developing simple cams. The opening and closing valves can be shown with intake and exhaust cams. Basic cam and follower showing theoretical curve and working curve. Cam displacement diagram from cam profile. Develop cam profile from given displacement diagram. Design problem — design a cam operated mechanism to provide a specific motion, e.g. a lock and hold device for production drilling on a drill press, a nut cracking device, an empty can flattener, etc.	
Gears	Types and development from friction discs (record player turn table), Pitch diameter, addendum — dedendum, etc. Draw a gear and pinion showing 3 or 4 teeth in mesh on two different size gears. Internal gears — show 3 or 4 teeth in mesh — internal gear will have reverse addendum, dedendum, etc.	
Auxiliary Views	Horizontal and Vertical reference lines, centre line as reference inclined reference line — individual problems in these areas.	
Revolutions	Horizontal, vertical and compound revolutions. Use wooden models to assist in visualization. Hip rafters and splayed leg of saw horse provide practical problems.	

BASIC

Topic or Operation	Related Knowledge	Notes
2. Surface Development and Intersections	True length diagrams — Scalene cones — truncated prisms — intersection of cone and cylinder, etc. Transition pieces as used in hot air ducts (commercial samples from Sheetmetal Shops). Develop pattern, then cut out and fit together with masking tape to check accuracy and fit.	
3. Pictorial Drawing	Isometric — irregular shapes — irregular curves — isometric sections — non-isometric surfaces — exploded isometric to show assembly sequence. Oblique — circles and arcs — irregular shapes — reverse angles — oblique sections — cabinet and cavalier projection.	
4. Perspective	Single point and two point. Prepared mimeograph sheets of plan and elevations to develop perspective. Scale drawing of doll house in perspective including doors, windows, chimney, etc.	
5. Architectural Drawing	Design a full sized house using methods suggested in Drafting 11 outline and produce all the necessary drawings. Local building by-laws should be covered and the house must conform to C.M.H.C. building standards. Site plan — Use transit to run levels on some area around the school. Draw the plot plan showing power lines, water, gas, sewage, phone lines, etc. Contour lines at one foot levels. Main floor plan — showing room sizes, window and door schedules wiring, plumbing, and all dimensions. Lower floor plan — (Foundation) showing location of all services.	

Topic or Operation	Related Knowledge	Notes
	Two or more elevations as required by local building inspectors. Section through exterior wall including stair details and all structural sizes. Two point perspective of house — apply rendering and or coloring to give artists impression of finished home.	
6. Navigation and Mapping	Develop from local resources such as marine charts, municipal and regional mapping offices.	

WOODWORK/ CONSTRUCTION



7. WOODWORK/CONSTRUCTION

7.1 Introductory Statements

The woodwork section has been designed to achieve the stated program goals for Industrial Education and to provide the opportunity for students to learn fundamentals which are prerequisite to further study.

It is recommended that woodwork instructors, in addition to project design, should give consideration to the construction of apparatus to demonstrate scientific principles. Such apparatus or jigs would be used to test practice joints made by the students and/or permit mass production of an article.

Certain operations in woodwork can be accomplished more rapidly, accurately, and effectively by machine than they can by hand, and certain other operations can be accomplished with more delicacy and refinement by hand than they can by machine. The student should begin to learn how to exploit the advantages of woodworking-machines and continue to develop hand skills.

It is essential that a student has a working drawing or working sketch prepared before attempting any practical work.
The drawing or sketch should be of a high standard and full-scale drawings and (or) rods should be used where practical. Students should be instructed how to prepare cutting lists, calculate material costs, and break out stock.

Materials used at each level would include some common B.C. softwoods and suitable hardwoods. Pupils should have some experience in working with hardwood.

It is intended that the specified learning outcomes be achieved through constructing projects of good design. The learning should be sequential based on suggestions in this subject section.

7.2 General Objectives

The student is:

7.2.1 to develop safe practices and orderly procedures in the use of woodworking tools.

7.2.2 to gain knowledge of the fundamentals of good design as applied to wood and other construction materials.

7.2.3 to practise good work habits while aiming for a high standard of craftsmanship.

7.2.4 to gain knowledge of industrial materials in modern society.

7.2.5 to become familiar with present and developing techniques in the construction industry and related industries.

7.2.6 to achieve a degree of competency which will enable him or her to secure successful employment, or further education in a vocational and/or technical school.

7.3 I.E. 8 - woodwork

Intended Learning Outcomes

Upon completion, the student should be competent and confident in the application of the following:

7.3.1 Basic

- the nature and use of wood such as structure and types of wood, and of fastening methods.
- working with wood to a reasonable degree of skill in the **hand operations** of cutting, shaping, and assembling.
- skill in the area of wood finishing, to include preparation of the wood, stains, and surface coatings.

- care and maintenance of equipment.

7.3.2 Supplemental

- working with the drill press and scroll or band saw.
- working with related synthetic materials.

BASIC

Topic or Operation	**Related Knowledge**	**Notes**
1. Wood		
Nature of Wood	Growth and structure of wood. The manufacture and seasoning of lumber.	Charts and samples of wood growth and structure should be available as teaching aids. Limit discussion of these topics as they relate to the manner in which wood is cut with edge tools, fastened with metal fasteners and adhesives, and is chosen for suitability of purpose.
2. Hand Operations		
Sawing	Construction, use, and cutting action of the following saws: Rip, cross-cut, and back-saw.	Sufficient repetion should be given to enable the student to identify these saws and to use them with a reasonable degree of skill. Handsaws should be used with sawhorses when feasible. Teach the effects of sawing supported and unsupported fibres. Use of striking or utility knife and bench hook.
Planing	Construction, adjustment, use, and cutting action of the jack, smoothing, and router planes.	Teachers should limit related knowledge to the assembly and adjustment of planes and upon the function of the cutting-iron, cap iron, lever cap, lateral adjusting lever and adjusting nut, and the sole ahead of the throat.
Gauging	Construction and use of marking-gauge.	Emphasize handling techniques to ensure that head remains on face surface and that pin trails.
Measuring	Types of rules.	Distinguish between the uses of the pencil, marking-gauge, and striking-knife.
Squaring	Construction and use of try square.	Emphasize the keeping of the handle on a face surface.
Laying out	Include laying out of duplicate parts.	Distinguish between the uses of the pencil, marking-gauge,
Chiselling	Horizontal and vertical chiselling. Construction, use, and selection of different types of chisels.	Emphasize correct methods of holding chisel, securing work, and use of mallet. Teach students that a dull edge reflects light. Teach selection of correct size.

BASIC

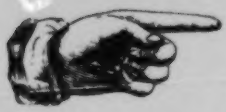
Topic or Operation	Related Knowledge	Notes
Boring	Use of bit brace with auger, centre, forstner expansive and twist bits. Use of auger-bit depth gauge. Sizing systems, cutting action of bits.	Teacher should demonstrate the cutting action of each of these bits. Students will use bits as required.
Drilling	Use of hand-drill. Identification of twist drills and their sizing. Cutting angle for woodwork 60° included angle.	Factional sizes only, or Metric.
Spoke-shaving	Use of curved and flat spoke-shaves to shape concave and convex surfaces. Adjustment of spoke-shaves.	
Filing	Cutting action of files.	Avoid the abuse of files.
Clamping	Use of Cee clamp and hand-screw.	Emphasize the need for keeping jaws adjusted to suit the job.
Hand-sanding	Selection and use of coated abrasives.	Compare modern abrasives and garnet with regard to cost, life, and efficiency of cutting.
3. Application of Hand Operations		
Sizing stock	Planing and testing face side. Planing and testing face edge. Gauging and planing to width. Gauging and planing to thickness. Finishing an end with plane. Measuring and sawing to length.	Stress the proper use of the try square, utility or striking — knife, and marking-gauge. Impress on pupils the need for: — Establishing a reference surface. — Working from a reference surface.
Butt-joints	Corner of tee butt joints. Application.	Refer to methods of fastening. Samples and drawings of joints should be available as lesson aids.
Dado or housed joints	Through, stopped and closed dados or housed joints. Application.	Pupils need construct one type only of these joints. Samples and drawings of joints should be available as lesson aids.
Cross-lap jointing	Corner laps, tee-lap, and cross-lap joints. Application.	Pupils need construct one type only of these joints. Samples and drawings of joints should be available as lesson aids.
Sawing curves	Construction, use, adjustment, and cutting action of a coping-saw.	Teach that teeth of a coping-saw cut on the draw stroke.

Topic or Operation	**Related Knowledge**	**Notes**
Fastening with nails	Include common, finishing, cigar-box, ten-test, upholstery nails and escutcheon pins.	Teach holding power of sloped nailing; rust-proofing and setting of nails.
Fastening with screws	Falt -, round -, and oval-head screws with Robertson, Philips, and slotted recess. Gauge sizes of screws. Countersinking, counterboring, shank clearance, and pilot holes. Uses of different types of screws.	Use soap or wax to lubricate threads.
Fastening with glues	Use of prepared liquid glues. Curing time.	Mention could be made of water-resistant glues.
4. Wood-Finishing		
Preparation of surface for finishing	Proper use of coated abrasive. Sanding with the grain, use of sanding-block, sanding work smooth and removal of tool marks.	Preparation of surface with smoothing-plane and abrasive should precede assembly. Discourage pupil's use of fine abrasives too soon.
Applying pigmented finishes such as wax stain	Preservative and decorative properties of finishing materials.	
Use and care of brushes		Teach use of appropriate thinner. Stress that paints and solvents must be stored in metal cupboards because of fire-hazard. Teach that rags soaked with finishing materials may ignite spontaneously and must be destroyed. A self-closing waste can must be used.

BASIC

Topic or Operation	Related Knowledge	Notes
	SUPPLEMENTAL	
1. Machines		
Sawing with a scroll or band saw	Selection of correct width of blade in relation to radius of cut. Difference between operational principles of scroll and band saws.	Pupils should demonstrate ability to use the equivalent hand-tool before progressing to machines. Pupils should pass a safety test before using the machines.
Using the drill press	Selection of drills. Correct speeds.	
Carving		Plain carving in the hollow or round. Use inside ground gauges. There is an additional opportunity here for individual design.
Scraping	Cutting action of a scraper.	Curved scrapers used after hollow carving.
Whetting chisels	Grinding and whetting angles.	A bright line reveals a dull tool. Roller-type chisel and plane-sharpening tools may be used for whetting. Examine edges under magnification.
2. Wood-finishing		
Application of synthetic finishes	Useful properties of such finishes.	
Applying transparent finishes such as shellac and sanding-sealer	Useful properties of shellac and sanding-sealer.	Teach comparative advantages and disadvantages of each with regard to bleeding and resisting water and alcohol.
Application of wax		Use steel wool between coats of transparent finishes.
Applying pigmented finishes		
Rubbing and polishing		Teach reasons for rubbing: — Levelling. — Reflection of light from a fine pattern of scored lines. Reasons for polishing — remove angles from scored lines.

7.4 I.E.. 9/10 - woodwork



Intended Learning Outcomes

Upon completion, the student should be competent and confident in the application of the following:

7.4.1 Basic

- techniques of project planning, design, and the orderly development of a project in wood.
- a reasonable degree of skill in the **basic operations** of cutting, shaping, fitting, and turning wood articles on **machine tools.**
- safety awareness through correct procedures when using machines.
- understanding the selection of different wood species, wood products, wood structures, and fastenings.
- finishing applications such as stains, fillers, sealers, surface coating and polishing of wood products.
- care and maintenance of equipment.

7.4.2 Supplemental

- cutting, shaping, fitting and fastening of specialty wood products such as plywoods, composition boards, laminates and other related products.

BASIC

Topic or Operation	Related Knowledge	Notes
1. **Materials**		
Wood	Appropriate use in building and furniture trades.	Suggested softwoods are pine, fir, cedar (red and yellow), spruce, and hemlock.
Lumber	Hardwoods and softwoods. Grades. Units of measure. Standard sizes. Economic laying out (waste factor). Costing (accounting).	Suggested hardwoods are maple, birch, alder, mahogany oak, walnut, teak, and other common woods. Review types and uses and fastenings. Review and apply Wood section of Grade VIII course.
Fastenings	Nails. Wood screws. Mechanical fasteners.	Stress the suitability of hardware to design.
Cabinet Hardware	Drawer pulls, hinges.	
Abrasives	Types of abrasives.	
2. **Hand Operations**		References to this section will be found in the outline for Industrial Education 8. Skill in the use of hand-tools can be developed by refining and fitting the work done on the machines. Alternate hand methods of constructing joints should be discussed and practice may be gained while the students are waiting to use the machines and thus prevent loss of production time. Projects should be designed with a measure of handwork. Safety practices are to be taught.
Planing out machine ripples	Safety precautions.	
Fitting joints		
Shaping irregular parts		
3. **Circular Saw**		Students should be given notes or demonstrations on safety precautions. Stress that the ripping fence and the mitre gauge should not be used at the same time. Basic maintenance of the saw should be an integral part of the instruction.
Cutting narrow stock to width	Safety precautions. Calculate cutting speed of circular saw.	
Cross-cutting	Use of a feather-board and push-stick.	
Cross-cutting duplicate pieces to length	Types of blades: —Cut-off or cross-cut — Hollow ground or planer — Rip saw — Combination saw — Dado head	

Topic or Operation	Related Knowledge	Notes
4. Radial Arm Saw		
Cross-cutting	Safety precautions.	Safety precautions should be given to students in form of notes and demonstrations. Basic maintenance of the saw is part of the instruction.
Ripping (demonstration)	Mounting the blade.	
Mitre cutting	Adjusting the dado head.	
Dado cutting		
5. Thickness Planer (Surfacer)		
Plane boards to thickness	Safety precautions. Cutting action of the surfacer. Feed mechanism of the surfacer.	Safety precautions should be given to the students in the form of notes and demonstrations. Basic maintenance to the surfacer is part of the instruction. Stress the need for a true surface on a board before the surfacer is used. Note that the surfacer will not remove wind or warp.
6. The Jointer		
Plane a face side (reference surface)	Safety precautions. Adjusting the fence. Adjusting the infeed table.	Safety precautions should be given to the students in the form of notes and demonstrations. The minimum length of a board planed on the jointer should be 12 inches. Be sure students understand that jointer guards must spring into rest position.
Joint a face edge (reference edge)	Cause of defects in jointing and planing stock on the jointer.	
7. The Drill-press		
Boring large and small holes in flat stock	Safety precautions. Installing a drill. Adjusting belt for various speeds. Adjusting the table.	Safety precautions should be given to the students in the form of notes and demonstrations.
Boring holes for dowel joints	Adjusting the depth control. Types of boring-tools. — Twist drill.	Use speed charts and post pulley speeds.
Counter boring for screws	— Machine spur bit. — Machine forstner bit. — Plug-cutter.	
Drilling holes for screws	— Hole-cutter. — Countersink. — Speed bit.	
Sanding on the drill-press		

Topic or Operation	Related Knowledge	Notes
8. **Hollow-chisel Mortiser** *Cut mortises*	Safety precautions. Cutting action of the hollow-chisel mortiser. Adjusting hollow-chisel and bit in the mortiser. Adjusting stock in the mortiser.	Use drill press attachments to convert machine for the work if mortising machine is not available.
9. **The Band Saw** *Straight cutting* *— Freehand* *Cutting curves and irregular shapes* *— Cutting shallow curves* *— Cutting sharp curves* *— Cutting complex curves*	Safety precautions. Size of band saws. Parts of band saw. Adjustment of band saw. Guide for height. Minimum cutting circles for band-saw blades.	Safety precautions should be given to the students in the form of notes and demonstrations. Maintenance checks to be made by operators. — Sharp blade. — Blade tension. — Thrust-wheel and jaw-guide setting.
10. **Scroll Saw** (Optional — teach if saw is available) *Cutting external curves* *Cutting duplicate parts* *Cutting internal openings*	Safety precautions. Size of the scroll saw. Parts of the scroll saw. Adjustment of the scroll saw. Installing a blade. Adjusting guides. Types of blades. Speed adjustments.	Safety precautions should be given to the student in the form of notes and demonstrations.
11. **The Grinder** *Simulate grinding chisels.* *Simulate grinding plane irons.* *(Use band iron)*	Safety precautions. Grinding speeds. Types of abrasive wheels. Grinding angles for tools. Water as a coolant.	Safety precautions should be given to the student in the form of notes and demonstrations. Stress eye protection with this operation. Students may be encouraged to bring plane irons and chisels from home for sharpening practice.

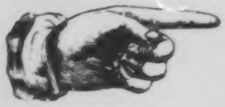
Topic or Operation	Related Knowledge	Notes
12. The Woodworking Lathe *Turning between centres (spindle-turning)* *Faceplate turning*	Safety precautions. Parts of the lathe. Lathe accessories. Measuring-tools. Turning-tools. Preparing stock for turning between centres. Mounting stock between centres. Mounting stock for faceplate turning. Calculating lathe speeds.	Safety precautions should be given to the student in the form of notes and demonstrations. Stress cutting rather than scraping in spindle-turning.
13. Disc Sander *Sand convex curves on edges.* *Sand end grain on small piece of wood.* *Adjust mitre joints to fit.*	Safety precautions. Choosing the abrasive discs. Replacing the abrasive discs.	Spindle sanding may be done by mounting a spindle on the lathe, drill press, or shaper.
14. The Saber Saw *Plunge cutting* *Internal cutting from a bored hole* *Cutting plywood* *Notching*	Safety precautions. Lubrication. Sabre-saw blades. Installation of blades.	Safety, electrical wiring and grounding precautions are to be taught. Motor maintenance and lubrication should be taught concurrently.
15. The Electric Hand-drill *Drill holes as required* *Driving screws*	Safety precautions. Drills: — Straight shank twist drills. — Machine spur bit. — Countersink bit. — Combination bit. — Spade-type bit. Chucks: — Key type. — Keyless type. Methods of designating twist-drill sizes. Screw-driver attachments.	Safety, electrical wiring and grounding precautions are to be taught. Motor maintenance and lubrication should be taught. Fasten chuck-key to the cord near the plug end to ensure removal key before drill is operated.

Topic or Operation	Related Knowledge	Notes
16. The Electric Router		
Cut grooves *Cut dados* *Cut rabbets*	Safety precautions. Types of bits. Inserting bits in collet. Preparing jigs and guides for various cuts.	Safety, electrical wiring and grounding precautions are to be taught.
17. Portable Orbital and Oscillating Sanders		
Using the sander for finishing new lumber	Safety precautions. General procedure for using the sander. Selecting the abrasives. Installing the abrasives.	Safety, electrical wiring and grounding precautions are to be taught. Maintenance is to be taught concurrently, e.g.: — Repairing the pad. — Cleaning the underside of the pad assembly.
Finishing materials *— Stains*	Colouring woods — dye colour, pigment colour. Types of stains — water, spirit, oil.	Safe storage of finishing materials to be taught. Refer to Fire Marshal's requirements for details on storage.
— Fillers	Paste and liquid.	
Primers and sealers	Shellac, synthetic resins. Oil base (diluted varnish)	
Surface coatings	Shellac, oil, varnish. Synthetic resins, polyurethene, lacquer.	Flat, satin, and high gloss. Finishes should be included in the instruction. Sources of and uses of solvents are to be part of the instruction.
Solvents	Turpentine. Petroleum solvents. Methyl hydrate. Lacquer thinner. Special solvents.	
Cutting and polishing materials	Wet and dry A-1 oxide paper. Steel wool and wax. Pumice and lemon oil or water. Rotten stone. Polishing compounds.	

Topic or Operation	Related Knowledge	Notes
	SUPPLEMENTAL	
Resin finishing	Cello finish. Fibreglassing resins — polyester and epoxy.	Note: Thermo setting plastics only to be offered if approved Ministry of Education spray booth Regulations and Specifications have been met.
Simple upholstering	Fillers: — cotton, — foam. Spring. Webbing. Tacks. Gimps.	
Plywoods	Hard and soft woods. Grades and glue types. Unit of measure. Standard sizes. Economic laying out (waste factor).	
Composition boards	Types of composition boards. Unit of measure. Standard sizes. Laying out (waste factor).	
Laminates	Types of laminates.	
Other forest products	Pulp, solvents, and cellulose.	
Glues — types	Animal, urea, phenolic and epoxy resins. Cements — contact.	Advantages and disadvantages of each type of glue should be taught.
18. Portable Belt Sander		
Surfacing wide boards with belt sander	Safety precautions. General procedure for using belt sander.	Safety, electrical wiring and grounding precautions are to be taught.
Finish sanding with belt sander	Installation of belts. Selection of abrasive belts.	Maintenance is to be taught concurrently, e.g.: — Cleaning the sander. — Lubrication.

Topic or Operation	**Related Knowledge**	**Notes**
	SUPPLEMENTAL	
19. Circular Saw *Bevel cutting* *Mitre cutting* *Using a moulding-head*		Teachers should refer to previous sections dealing with these machines. Stress safety practices with all. **Only a demonstration** is required at this level.
20. Radial Arm Saw *Compound mitre cutting*		
21. The Jointer *Chamfering* *Tapering* *Rabbeting*		
22. The Drill-press *Jig boring*		
23. The Band Saw *Resawing* *Cutting circles with a jig* *Double profile cuts*		
24. The Electric Router *Edge moulding* *Dovetailing with template* *Template routing*		

7.5 Construction 11



Intended Learning Outcomes

Upon completion the student should have expanded his or her abilities in the applications of the following:

7.5.1 Basic

- performing in a safe and orderly way a wide variety of specialty machine operations, including shaping, turning, multiple cutting, duplicating parts, using "jigs" and advanced "set-ups".
- aspects of good industrial design and to relate this in the design, planning and construction of wood products of a high standard of craftsmanship.
- using wood and other related materials as they are used in the industrial society.
- skill in using various methods of wood surface protection and finishing.
- problems and difficulties as related to the mass production of wood products in our industrial world, through discussion and/or working on a mass production project.
- care and maintenance of equipment.

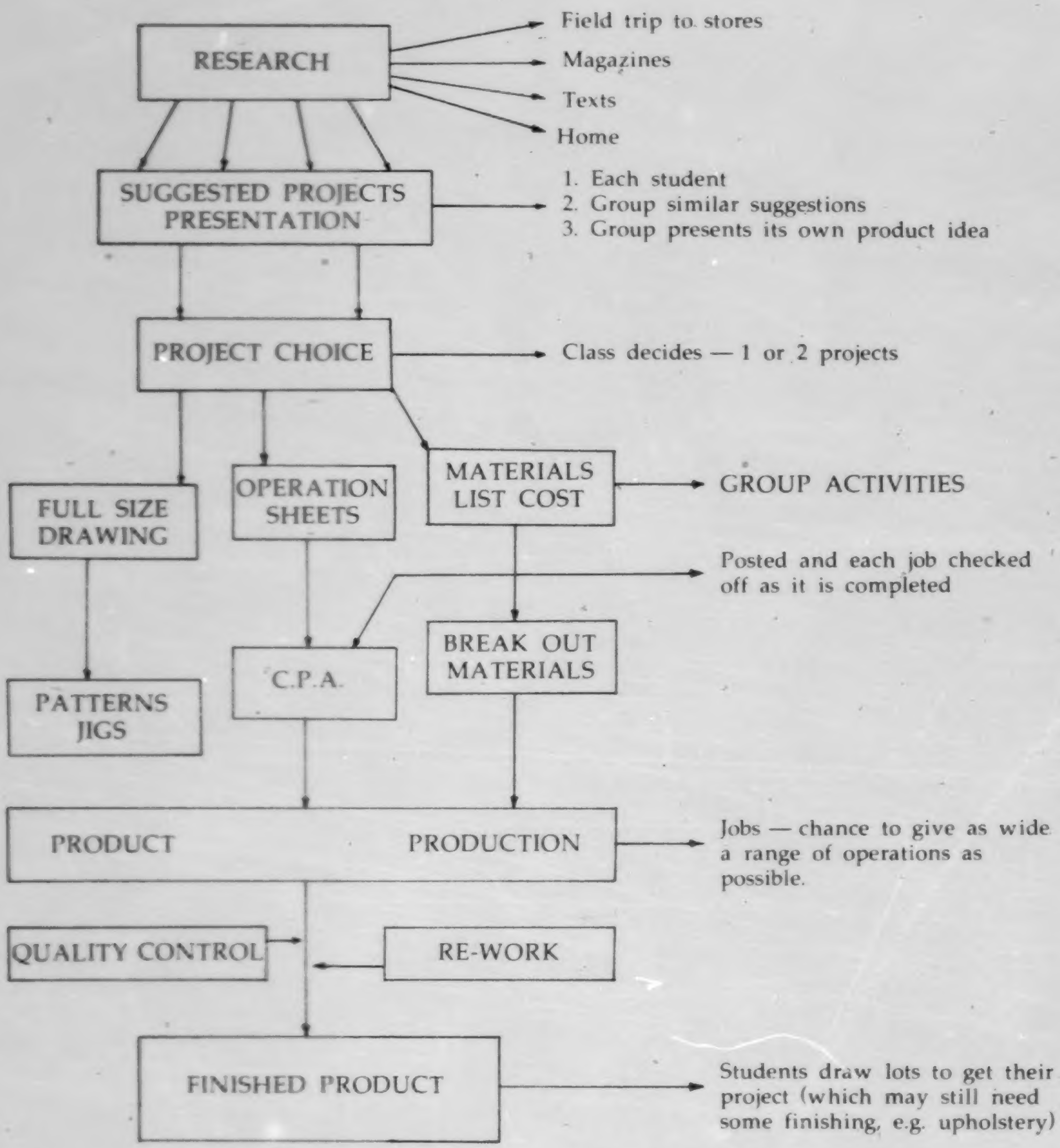
Topic or Operation	**Related Knowledge**	**Notes**
1. Machine Woodworking — Safety		
Shop safety	Safety studies Industrial safety Compensation requirements	
Machine Safety	Machine design Individual machine dangers Machine demonstrations Guards and their functions Safety posters and films Safety tests	The safe operation of any machine should be part of the instruction with regards to the machine. Safety should not end with the instruction but should be a continuing consideration. If the teacher is safety-conscious and uses safety procedures when using machines, his students are more likely to develop the same safety-consciousness.
2. Machine Woodworking — Machines		
Power saws *— circular* *— radial* *— band*	Safety precautions Features and functions Set-ups and operations Types of blades Industrial applications	The students should be able to set up the machines for all basic operations.
Planing and shaping *— Jointer* *— Thickness Planer* *— Shaper* *— Uniplane*	Safety precautions Features and functions Whetting and setting up of shaper cutters Whetting and setting up of jointer and planer knives	
Drill Press and Mortiser	Wood characteristics and machine marks	
Portable machine tools *— hand saw* *— drill* *— router* *— Sabre saw*	Specialty machining Safety and maintenance Features and functions Accessories Industrial uses	
Power finishing *— disc sander* *— spindle sander* *— portable orbital sander* *— portable belt sander* *— horizontal belt sander* *— belt and disc sander*	Features and functions Safety precautions Study of abrasives Sanding related to finishing	

Topic or Operation	Related Knowledge	Notes
3. Machine Woodworking — Furniture Production		
Mass production techniques applied to manufacturing an article from wood	Production analysis Factory layout Billing of materials Breaking out materials Factory machine operations Use of jigs and templates Multiple cutting	Students should become familiar with mass-production methods. Some products should be made involving mass-production methods. See Mass Production Chart Page
4. Design		
Industrial design — design an article of furniture **suitable** *for factory type of manufacture*	Principles of design Design applied to factory production Blueprint reading Material adaptation Designing in the home Assembly line methods	Student to make **proto type** of the article designed. Doors and drawers should be incorporated in the design.
5. Materials		
Wood	Common construction woods Characteristics and recognition of furniture woods. Growth of wood Grading of furniture wood Seasoning of wood	Samples of all materials should be available as teaching aids. Safe storage and handling should be stressed.
Manufactured wood products	Mouldings and panelling Processed boards Plywoods Manufacture and uses of wood products.	
Laminates	Manufacture and uses Cutting methods Bending, shaping and edging Adhesives and laying techniques	
Adhesives	Common wood glues Contact cements Catalysts and hardeners, expoxy Temperature control Clamping and timing	
Fastenings	Common fastenings Production fastenings Component assembly methods	Production fastening devices would include staples, nailing machines, power drivers, etc.
Abrasives	Manufacture Types, grades and uses Polishing lubricants	

BASIC

Topic or Operation	Related Knowledge	Notes
6. Furniture Construction		
Construct the article designed in Unit 4.	Layout rods or full size drawing Material billing Breaking out material Multiple cutting Dadoing, mitering, machining mortises and tenons Other machine operations as required.	Students should be able to set up machines for all basic operations. Use of dado stops, etc. Students should be encouraged to make and use jigs even if the student is to use it for only one operation — this is the factory method. The jigs the student makes should be assessed as part of his work.
7. Hand Tool Operations		
Edge tool grinding	Safety precautions Types and speeds of emery wheels Grinding angles Coolants	A student should be able to recognize when a tool is dull. A student should realize that a sharp tool is a safe tool. A student should be able to recognize the fine quality of work produced by a sharp tool as opposed to a dull tool.
Edge tool whetting	Types and care of oil stones Whetting angles	
Tool usage	Safety precautions Selection of correct tools Care and adjustment of tools Correct usage of hand tools	The correct care and use of hand tools is an integral part of a craftsman's training. Hand tools must be used to refine machine tool operations.
8. Finishing		
Furniture finishes by hand methods	Material study Surface preparation Application of — shellac — varnish — synthetics Fillers and abrasives Polishing	Modern finishing materials are volatile and toxic. Students must be made aware of fire hazards and health hazards. Stress safe home use and storage of finishing materials.
Production finishing	Production assembly line Production finishing of parts Dipping baths Spraying Drying temperature Machine polishing	Note: Spray finishes only to be offered if Approved Ministry of Education Spray Booth Regulations and Specifications have been met.
9. Upholstering	Foam Springs — can't sag, etc. Webbing Staples Gimps	

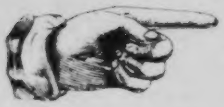
MASS PRODUCTION


RESEARCH
Field trip to stores
Magazines
Texts
Home
SUGGESTED PROJECTS PRESENTATION
1. Each student
2. Group similar suggestions
3. Group presents its own product idea
PROJECT CHOICE
Class decides — 1 or 2 projects
FULL SIZE DRAWING
OPERATION SHEETS
MATERIALS LIST COST
GROUP ACTIVITIES
Posted and each job checked off as it is completed
PATTERNS JIGS
C.P.A.
BREAK OUT MATERIALS
PRODUCT PRODUCTION
Jobs — chance to give as wide a range of operations as possible.
QUALITY CONTROL
RE-WORK
FINISHED PRODUCT
Students draw lots to get their project (which may still need some finishing, e.g. upholstery)

TYPES OF PROJECTS
- stools
- chairs
- tables
- garden, patio furniture

Construction 12
- green house
- garden shed
- tool shed

7.6 Construction 12



Intended Learning Outcomes

Upon completion the student should have expanded his or her abilities in the applications of the following:

7.6.1 Basic

- Good work habits and a high degree of safety-consciousness.
- Familiarization with present and developing techniques in the construction industry and/or related construction industries.
- Skills and experiences in the constructing and fabricating of realistic projects of wood or related (substitute) materials.
- careful, critical and analytical judgements in the use of materials: size, type, shape, strength and structure.
- study in depth certain specific areas of the construction industry.
- study and use of synthetic (plastic) materials and processes.

Note

- students under actual working conditions must conform to W.C.B. regulations. These regulations must be adhered to when using power equipment. Protective head-gear must be worn when applicable.
- power staplers and nailers are not to be used by Construction Program students in secondary schools without special school board permission.

CONSTRUCTION 12 - MODEL

1. House Building or Related Project

1.1 Preamble

A house building - construction project may be:

a) Site Built House — following local codes and CMHC
(Canadian Wood Frame Construction)

b) Modular House or Building — 10 or 12 ft. Sections
(See information sheet)

c) Panelized Prefab Building
(See information sheet)

Construction 12 - MODEL
House Building

BASIC

Topic or Operation	Related Knowledge	Notes
1. Materials		
Identification of lumber grades	Manufacture and seasoning of wood Defects of lumber Grading of lumber Units of measure — shrinkage allowance Care and conservation on job	When possible — Units 1,2,3 and 4 are intended to be taught as the material is being introduced along with the practical work.
Practice identification of various wood species	Characteristics of wood Identification of species Sources of commercial wood Estimating of quantities and cost	
2. Machine Operations		
Safety on the job	Job safety study Compensation requirements Scaffolds Material handling Safety clothing and hats	Reference: Workers' Compensation Board posters, booklets, and films.
Safety with portable tools	Temporary electrical supplies Electrical grounding Guards and their care	Request to be put on Workers' Compensation Board mailing list.
Shop safety	Guards and their functions Machine design Safety posters, films and tests	
3. Stationary Power Tools		
Radial arm saw *— cutting to length*	Characteristics of radial arm saws Methods of checking saw for accuracy Cutting multiple lengths Safety practices	
— ripping to width	Machine adjustment Selection of blades Rate of feed and cutting speeds Kick back prevention Safety precautions, hand positions and push sticks	
— specialty cutting	Dadoes, grooving, rebating and moulding Special machine set-ups Selection and mounting of blades Use of jigs Rafter and stair cutting Extra safety measures necessary for these special cuts.	

BASIC

Topic or Operation	Related Knowledge	Notes
4. Portable Hand Tools		
Electric handsaw	Guards and their operation Selection of blades Saw sharpening Types of abrasive blades, use and safety precautions	Safety and use of grounded extension cords should be emphasized
Electric drill	Safety precautions	
5. Foundations		
Establishing building line	Blueprint reading to determine location of building on lot Building codes Temporary excavation stakes	This should be done outside on school ground.
Setting batter boards or equivalent	Working allowance from foundation lines Tools for sharpening and driving stakes Use of carpenter's and builder's level or transit Methods of marking batter boards Squaring lines and measuring to size on batter boards — 3, 4, 5, method — measuring diagonally	
Cement Products	Properties and manufacture of Portland cement Manufacture and handling of aggregates Proportion or ratio of components Relation of water — cement to tensile strength — additives Mixing and transportation Handling and placing methods	Reference: — Portland Cement Association. — N.H.A. Standards, and — Local Building Code
Layout and construct — concrete footings	Types of concrete footings Material used Construction of footings Methods of placement Method of levelling footings Tieing and bracing footings in place Setting bolts or steel reinforcing rods	

Topic or Operation	Related Knowledge	Notes
Construct foundation forms	Plumb line, straight edge and level from building lines Location of building lines. Blueprint reading to determine sizes. Features of various spreaders and ties. Methods of aligning Squaring Features of bracing Levelling: — hand level — water level — levelling transit Placement of steel	This may have to be done by constructing partial forms or models. Introduce commercial type forms. Field trip to see industrial methods.
Pouring concrete	Methods of making concrete on the job Ready-mix concrete Method of handling and placing concrete Method of estimating amount of concrete required Concrete agitators Slump test	Literature from Portland Cement Association. — The Drama of Cement Making — Making good concrete — A complete course in Concrete — Films from Portland Cement. Core samples of concrete. Students should be given experience in mixing concrete. This may take the form of patio blocks, flower pots, etc.
6. Basement Framing		
Check foundation walls for accurate layout	Methods of checking foundation	Reference — Housing Standards, Canada.
Place, align and level sills	Methods of checking foundation Method of levelling and aligning sill Use of damp course	
Assemble and erect basement walls	Standard methods of marking layout Methods of assembling corner posts Method of framing openings Method of framing girder pockets. Methods of erection: — plumbing and temporary bracing	It may not be possible to carry out all these operations, however, the topics should be demonstrated and discussed.

Topic or Operation	Related Knowledge	Notes
	Methods of permanent bracing Use of bearing partitions Method of placing double plates Method of determining spacing and height of columns Types of girders Location of joints nailing and assembly of laminated girders Method of jointing solid girders Prevention of decay in girder pockets Placing and aligning girders	
7. Sub-Floor Framing and Sheathing		
Placing floor joists	Size, span and spacing of joists Methods of framing ends Standard methods of marking layout Methods of jointing over girders or bearing partitions Methods of framing floor openings Use of additional joists under parallel partitions Crowning and nailing joists	These operations should be carried out by students as full-size or scale models.
Placing bridging	Functions of bridging Types of bridging Alternative use of a ribband Number of rows required Method of nailing herring-bone bridging	
Placing sub-flooring	Types and sizes of material including plywood Methods of laying with advantages and disadvantages of each method Position of joints Use of power equipment Type and quantity of nails.	Glued sub-flooring.
8. Wall Partition Framing and Sheathing		
Study of various types of insulation	Grades and thicknesses Features and functions Types and location of vapour barriers Ventilation and condensation control	
Selection and cutting material	Method of constructing a cutting box Selection of material to avoid waste Use of power equipment Calculating lengths of members	These operations should be carried out by students as full-size or scale models.

Topic or Operation	**Related Knowledge**	**Notes**
Assembly of members	Standard methods of layout Functions of members Method of assembling headers Placing and jointing plates Methods of assembly and nailing	The students must be made aware of contemporary prefabrication methods of building. If it is desirable this method may be used.
Raising, plumbing and temporary bracing walls	Methods of raising, plumbing and temporary bracing walls Safety precautions Methods of providing nailing for inside finish at partition intersections Method of placing double plates	
Placing permanent bracing in walls	Types and methods of placing permanent bracing	
Placing girths, fire stops and backing	Functions and positions of girths, fire stops and backing	
Application of sheathing	Types of materials Methods of application Sheathing before raising the walls	
Erecting scaffolds	Safety regulations Methods of erection Special types of scaffolding	
9. Ceiling Framing		
Placing ceiling joists	Size, span and spacing of joists Standard methods of layout Safe methods of raising joists Methods of jointing joists over partitions Crowning and nailing joists Use of bridging and strong backs to support long spans Framing openings in ceiling joists	These operations should be carried out by students as full-size or scale models. The students must be made aware of contemporary prefabrication methods of building. If it is desirable this method may be used.
10. Roof Framing, and Sheathing		
Roofing materials.	Types of wood shingles Types of asphalt shingles Flashing Plastics — metal Shakes Concrete roofing	

Topic or Operation	Related Knowledge	Notes
Laying out roof plans	Types of roofs Roofing terms	
Laying out top plate and ridge boards	Use of steel square	
Raising ridge boards	Methods of raising, aligning, bracing	
Cutting Common Hip and Jack Rafters	Layout of plumb, seat and check cuts Methods of calculating lengths Overhang Shortening	Each student should lay out and cut at least one full-size rafter of each type.
Construction of Gable and/or Hip Roof	Use of steel square Collar ties Bracing Openings Gable end studs Gable Vents	
Trusses	Nailing schedule Engineering specs.	
Roof Sheathing	Study the types of roof coverings commonly used "H" clips	
Roofing		
Flashings	Study of flashing material and methods	
11. Stairs		
Lay out and cut simple stringers	Stair design and safety Use of framing square Open and closed stringers Storey poles Methods of cutting	This should be covered by live work where possible, if not possible short stringers can be laid out and cut in both open and closed types.
Placing stringers	Fastening, placing and alignment of stringers	
Concrete stair forms		

BASIC

Topic or Operation	Related Knowledge	Notes
12. Wall Coverings		
Applying paper underlay	Types, purposes and application methods Operation and safe handling of staple guns and hammers	It may not be possible to undertake this work but students should observe it by visiting buildings under construction and should understand it thoroughly.
Wood sidings *— smooth face* *— recessed face* *— rough face* *— waney edge*	Suitable woods Manufacturing processes Lap and spacing Joining and mitering Nails and nailing Priming and painting	
Plywood sidings	Study of types and manufacture Edge treatment Caulking and nailing	
Composition sidings	Types, sizes and shapes Care in handling Cutting and nailing	
Metal sidings	Materials, shapes, types and sizes Bonderizing and surface treatment Handling precautions Cutting, caulking and fastening	
13. Interior Finish		
Installing insulation *— Wall*	Types, batt, blanket and metal foil Features and functions Care in handling Cutting and stapling Study of vapor barriers and temperature differentials	It may not be possible to undertake this work but students should observe it by visiting buildings under construction and should understand it thoroughly.
— Ceiling	Types and features Vapor barrier and condensation	
Installing wall and ceiling covering lath *— Gypsum*	Types, sizes, weights and and manufacture Cutting and nailing Metal corners, valances, grounds and furring Wire lath Crack prevention	
— Gypsum board	Types, sizes and care in handling Cutting and nailing Corner beads, joint filling Finishing	
— Plywood, composition boards and ceiling tile	Types of materials Manufacturing process Nailing, joint and surface treatment Furring and backing strips	

BASIC

Topic or Operation	**Related Knowledge**	**Notes**
14. Sub-Trades		
Plumbing	Materials involved	These sub-trades should be considered only to the extent that they are involved in the construction of a building, e.g. The student should know how to frame openings for a chimney, heating and plumbing. He should have an appreciation of the problems of the sub-trades. Suggest field trips and research projects.
Electrical	Coordination of sub-trades in an actual building contract	
Bricklaying	Costing in relation to a contract	
Plastering		
Painting		
Roofing		
Heating		

15. Post and Beam Construction

Note: Full scale Post and Beam construction will not be practical in schools where "on the grounds" construction is carried out, however, a study of modern trends in Post and Beam construction is desirable.

Study of special problems in Post and Beam construction	Advantages and disadvantages of post and beam Concentrated loads and their effects on footings Variations in construction methods
Study of methods of fastening	Methods of fastening feet of posts Methods of fastening beams to posts Methods of fastening roof beams
Study of Post and Beam roofs	Types of roof construction Spacing and span of roof beams Types of roof planks Methods of fastening and joining roof planks
Study of curtain walls	Types of materials used Problems in placing curtain walls
Study of interior walls	Use of partial walls Types of partial walls Use of storage walls

Topic or Operation	Related Knowledge	Notes
16. Interior Finish		
Fitting and hanging floors	Fitting allowances Hand methods of hinging Machine routing with a jig Lock installation	
Fitting and installing sliding and folding doors	Types and sizes Types of hardware Methods of hanging and adjustment	
Fitting and installing sash	Types, sizes and materials Types of hardware Fitting and clearances Screening and weather stripping	
Applying interior trim	Types of standard materials used Mitering and coping of mouldings Surface enrichment with overlays	
Installing manufactured fixtures	Methods of checking building for true Scribing and fitting Methods of fastening	
Selection and Use of Builder's Hardware and Fastenings	Study the features, functions and installation practices for interior hardware Hardware as it effects good design Nails, screws, bolts and fasteners used effectively for strength and appearance	
Floor laying — Wood	Suitable woods Types, sizes and grades Laying practices and handling care Floor nails Nailing machines	
— Composition Tiles	Types, sizes and composition Underlays, nails and filling Adhesives, spreaders and setting time Methods of laying and cutting	

BASIC

Topic or Operation	Related Knowledge	Notes
1. Millwork and Joinery		
The application of plywoods in industrial manufacturing	Plywood grading to specifications Plywood grades in relation to factory costs Plywood strength to weight ratio Plywood cutting and finishing processes.	Reference: — Fir Plywood Handbook — Plywood Manufacturers' Association
Construct door and window frames	Standard stock shapes and sizes Specialty casings, jambs and trim Machine operations Pre-cut and factory assembled frames Types of pocket sliding frames	
Design and layout of kitchen cupboards	Kitchen planning Cabinet design Full size drawing Blueprint reading Estimating	These operations should be completed by using plywoods, pressed boards, laminates and other contemporary products. It is important that modern production methods be used even if only one article is produced.
Constructing base cabinets	Gable and carcass construction Types of joints Machine operations Safety precautions	
Constructing and fitting drawers	Material and hardware Types of joints and fastenings Types of slides and guides Machine set-ups	
Cutting and hanging doors	Types and location of hinges Types of hardware and their installation	
Installing counter tops	Types of coverings Methods of application Cements and trim Special tools and operations	
Constructing upper cabinets or built-in shelving	Types of adjustable and removable shevles	
Installation	Scribing to wall Methods of fastening to buildings	

BASIC

Topic or Operation	Related Knowledge	Notes
2. Tool Sharpening		
Edge tools	Methods of grinding and whetting edge tools Selection of correct grinding wheels and oil stones Correct grinding and whetting angles Grinding of drills Sharpening of bits Care of edge tools Safety precautions	
Toothed tools	Jointing the teeth Setting the teeth Filing the teeth Selection of proper files	Opportunity should be given each student to set and file both hand and circular saws.
3. Industrial Coating		
Paints and varnishes	Safe storage and use — oil — water — synthetics	Students should be aware of trends in contemporary finishes. Stress solvents for various types.
Use and care of equipment	Brushes Rollers Spray equipment	
4. Introductory Survey Work		
Mechanics	Power and types Cross hair Levelling plane Telescopic plane	Reference: Level and Transit — Churchill. Obtainable from: Publication Services Branch Ministry of Education Parliament Buildings Victoria, B.C. V8V 2Z6
Care and protection	Transporting Weather Maintenance	This is a complete course in itself and might well be used as a text.
Setting up transit	Solid footing on fill Slippery surfaces	This work should be done outside preferably, but can be done in school hallways, etc.
Transfer of Levels	Use of surveyors' bench marks Datum points Description of land	
Use of Rod	Establish heights and falls Signals Reading	
Layout of buildings	Set angles Establish right angles Check diagonals	
Offsets	*Set angles*	

7.7 PLASTICS

i. Introductory Statements

It was decided to consider plastics as a component of the Construction courses in the I.E. Program.

The student should apply the skills and knowledge gained in other areas of Industrial Education when solving technical problems in the plastics field.

Work with thermosetting plastics is subject to Ministry of Education Regulations and Specifications.

ii. General Learning Outcomes

The student should develop an appreciation of the plastics industry including materials, processes, and products.

The student should gain experience and skills in basic operations utilizing plastic materials.

The student should develop an appreciation of good design and workmanship when using plastic materials.

The student should develop good safety habits relative to working with plastics.

The student should acquire consumer knowledge concerning plastic materials and products.

The student should become acquainted with the occupations relating to the plastics industry.

iii. More Specific Learning Outcomes

The student should be able to IDENTIFY PROPERTIES of some of the types of materials of the Plastics Industry.

Acrylics
Polyethylene
Polystyrene
Polyester Resins
Polyurethane Forms
Fibreglass
Plastisols

The student should be acquainted with the RAW MATERIALS OR SOURCES of the plastic material.

The student should understand the PROCESSES of the plastics industry.

Injection Moulding
Thermoforming
Extrusion Moulding
Foaming
Polystyrene Moulding
Compression Moulding
Resin Casting
Reinforced Moulding
Bonding & Fastening
Calendering
Transfer/Plunger Molding
Plastisol Casting
Machining
Coating
Laminating
Rotational

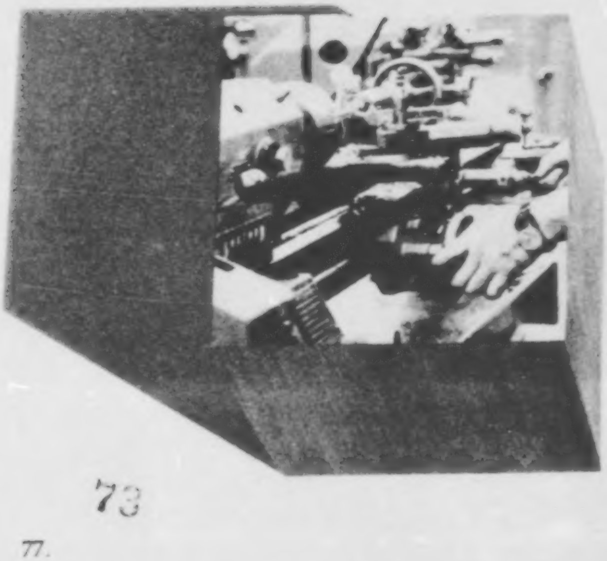
The student should become aware of some of the USES AND PRODUCTS of plastics.

- Transportation Industry
- Automobiles
- Aerospace, Aircraft
- Construction Industry
  - — adhesives,
  - — coatings,
  - — finishes,
  - — hardware, etc.
- Furniture
- Household goods
  - — appliances,
  - — kitchenware,
  - — fabrics,
  - — coverings,
  - — toys
- Agriculture
- Marine
- Medical
- Recreation
- Packaging
- Architecture
- Artistic
  - — aesthetic uses
- Communications
  - — Electronics

The student should gain some EXPERIENCE IN MACHINING, FINISHING, and ASSEMBLING parts.

- Cutting
- Machining
- Filing
- Buffing
- Polishing
- Joining
- Fastening
- Engraving
- Hot Stamping

METAL



8. METAL

8.1 Introductory Statements and General Objectives

In addition to the program goals for Industrial Education previously listed, the metal area has the following general objectives:

8.1.1 **Technical Vocabulary** — The student should develop a technical vocabulary and an ability to understand instructions.

8.1.2 **Forming and Fabrication** — The student should gain practical experience in the forming and fabrication of a variety of materials.

8.1.3 **Skill Development** — The student should develop skills and safe practices in using hand and machine tools to form metal.

8.1.4 **Finishing** — The student should explore the different methods of finishing and treating metals, and applying protective coatings.

8.1.5 **Consumer Education** — The student should, through practical experience, develop a knowledge of metalworking tools and metal products.

8.1.6 **Environment** — The student should become aware of the side effects of industrial processes such as pollution and resource depletion.

8.2 I.E. 8 - metal

Intended Learning Outcomes

Upon completion, the student should be competent and confident in the application of the following:

8.2.1 Basic

- properties (such as strength, malleability, melting point), uses and limitations of various metals such as steel, copper and aluminum.
- hand tools and simple machine operations. The student should acquire basic skills in laying out, measuring, cutting, forming and basic processing of metal.
- skills in the various methods of joining metals, such as seaming, soldering, spot welding, riveting and bonding with adhesives.
- skills and knowledge of the various methods of finishing and protecting metals, such as painting, enamelling, heat treating, polishing, etc.

- care and maintenance of equipment.

8.2.2 Supplemental

- basic skills in the operation of the drill press, grinder, buffer and portable electric hand drills.

Topic or Operation	**Related Knowledge**	**Notes**
1 Sheet Metal		
Laying out	Scriber, square, rule dividers, prick punch, ball peen hammer	Layout may be done directly on the sheet metal, working from squared side and end.
Cutting	Tin snips, shears, nibbler, (hand and power) squaring shears	The use of left-hand, right-hand and straight snips. Emphasize the safe methods of using sheet metal to avoid cuts.
Folding	Single, double hem, bar-folder, bending bars	Various types of bending devices, such as; bar-folder, brakes, vises, bending-bars, etc., should be available for student use. Explain merits of double hem over single hem.
Seaming	Lap, groove	
Soft soldering	Cleaning, tinning, types of irons, solder composition, fluxes	The use of an old file for physical cleaning is good practice. Cleaning agents such as Sal Ammoniac or zinc chloride are necessary for chemical cleaning. The soldering iron should not be overheated. Demonstration should show the need for flux (a) to chemically clean and (b) to assist the flow of solder. Heat penetration from a sufficiently hot iron could be demonstrated effectively. Post soldering surface cleaning.
Punching	Whitney punch, hand punch, Hollow punch, lead block	Proper assembly of matched punch and die must be stressed. Mechanical principles involved should be taught. Maximum use of this machine within its limits should be encouraged.
Cylinder forming	Slip roll former	Relevant mathematics may be taught to support practical application.

Topic or Operation	Related Knowledge	Notes
2. Band Iron		
Laying out	As listed in sheet metal, also centre punch, hermaphrodite calipers, surface gauge, appropriate layout fluid	Use of chalk, whiting, blue layout ink, copper sulphate. Emphasize correct use of centre punch. Emphasize correct weight and safe use of hammers.
Cutting	Bench shears, hacksaw, cold chisel, power hacksaw, vertical band saw	Some discussion on the proper use of these tools is necessary to avoid damage. Safe working practices should be stressed at all times. Discussion of hacksaw blades with relation to the number of teeth for the job concerned, direction of cutting, and proper working speeds is important. Proper use of cold-chisel should be demonstrated. Mushrooming of the cold-chisel and safety precautions necessary should be explained. Mechanical principles involved in the operation of the tools should be noted.
Bending	Allowances, effects of bending, hot and cold	Demonstrations will show the effect of shrinkage in bending metals.
Hammering	Types of hammers, effects of hammering. Decoration	Ball-peen hammer should be discussed with relation to weight, face types, and proper method of holding. Other hammers, such as tinner's, blacksmith, and art metal, should be mentioned briefly to show differences. Discuss work hardening, malleability, stretching and decoration.
Punching	Whitney punch	Proper assembly of matched punch and die must be stressed. Mechanical principles involved should be taught. Maximum use of this machine within its limits should be encouraged.
Forming	Jigs, benders, (Diacro or Hossfeld)	Thickness of metals and correct procedures to be considered.
Filing and Draw filing	Types of files, cutting action care and use of files	Discussion should be limited to the difference between a double-cut and a single-cut file and the common shapes. Stress the use of a file-handle.

Topic or Operation	**Related Knowledge**	**Notes**
3. Art Metal *Design*		Students should be shown what is considered good design, and several examples should be put forth for their guidance.
Forming	Raising an edge, sinking, pressure forming, annealing	The wood moulds could be made by the instructor, using end-grain hardwood blocks, and sand bags. Demonstration should be made to show clearly the effects achieved by carved and bumped recesses in wood blocks. Proper annealing procedures for both copper and aluminum should be shown with the pickle bath for cleaning. Different methods should be demonstrated to show how to properly trim and level the top of the dish when it is completed.
Finishing	Colouring, etching, chasing, polishing, decorating, protective coatings	The finishing of the project way of colouring and polishing should be kept relatively simple at this level. It is suggested that liver of sulphur be used for colouring and the polishing medium should be steel wool. Ordinary wax could be used for a final polish. The lining and matting tools used on these projects should be kept to a relatively simple selection. Any small hammer is suggested for the job, preferably a 4-oz. ball-peen hammer.
Enamelling	Glazes, fluxes, cleaning	
4. Casting	Safety procedures. Open and closed moulds. Displacement, (INVESTMENT). Pouring temperature	It is suggested that small simple forms be used in this operation to demonstrate the principles of hot-metal casting. Wood, metal, or sand moulds may be used. Safety precautions concerning hot liquid metals and mould materials should be stressed. Lead alloys could be considered. Face protection is essential.

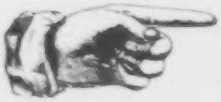
Topic or Operation	Related Knowledge	Notes
5. Forging		
Hot flattening	Identification tests for mild steel, forging equipment, forging heat, measuring hot metals.	Methods of heating could include both gas and forge fires. Where forge fire is available, the student should be shown how to build the fire correctly and be made aware of the importance of a clean fire.
Forming	Scroll, brackets, twisting, bending, offset, upsetting	
Drawing to a point	Square and round point	Suitable eye protection should be worn when forging. As far as possible the job should be finished with the hammer and anvil. Emphasis should be placed on the fact that in forging a point the blows should be sufficient impact to swage the metal. The use of light tapping blows will tend to stretch the metal on the outside and cause the "piping" effect. Care should be taken to avoid burning a point on a second heat.
Cutting and punching	Specialized tools	
Tool steel	Identification tests, forging heats, normalizing, hardening, tempering, quenching media. Testing for hardness.	The important difference between mild steel and carbon tool steel should be stressed. The important contribution of tool steel to modern technology could be introduced. Some of the common danger points in forging carbon tool steel are (1) overheating and (2) hammering the steel when it is below a red heat. It is suggested that, at this level, 3/8" - diameter stock should be the limit that the student should be asked to forge. A carbon tool-steel job should be finished by the hammer as much as possible to avoid wasting time filing and polishing surfaces unnecessarily.
	Heat treatment of carbon tool steel	Stress the importance of normalizing after forging carbon tool steel. It is suggested that the hardening temperature be indicated by the use of a magnet, and when the non-magnetic point has been reached, the job should be quenched. For quenching, oil or tallow should be used. To test for hardness, the heel of the file should be used.
		The purpose of tempering after hardening carbon tool steel.

BASIC

Topic or Operation	Related Knowledge	Notes
6. Drilling		
Portable hand drill	Safety precautions, types, variable speed, reversible	For operating speeds, it is suggested that the rule of thumb be used; i.e., a small drill should operate at high speed and the larger drills at lower speeds. Work should be held securely by a mechanical device.
Drill press	Operating speeds, coolants, clamping, countersinking. Types of twist drills.	
7. Grinder		
Freehand grinding	Safety precautions stone types	Extreme care should be exercised on the part of the instructor to keep the grindstone and rests all in excellent condition and adjustment to avoid any possible chance of accident. In all grinding operations it is important that the project be of sufficient size to be ground with safety. Grinding for metal-removal should be kept to a minimum. Goggles must be worn for all grinding operations.
8. Fastening		
Riveting	Rivet types, sets, pop rivets	Rivet classification with regard to size and weight should be discussed briefly.
Soldering	Hard and soft, fluxes, tinning, types of irons	See sheet metal
Spot welding	Safety precautions	
Temporary fasteners	Sheet metal screws, self-tapping nuts, bolts	
Adhesives	Glues, epoxies	Safety precautions (intoxication, accidental bonding, etc.) should be stressed.
9. Wire Work		
Twisting	Jigs, allowances, effects of twisting. Wire types.	Demonstrations will show the effect of shrinkage in twisting metals. At this level the student should not be expected to calculate these allowances.

Topic or Operation	Related Knowledge	Notes
10. Measuring		Emphasis upon, and development of, the metric system should be stressed.
11. Reading Drawings		Some correlation with drafting program may be required. Knowledge of drawing standards and common graphic representations is advised.
	Supplemental Refer to Page 80. Section 8.2.2	

8.3 I.E. 9/10 - metal



Intended Learning Outcomes

Upon completion, the student should be competent and confident in the application of the following:

8.3.1 Basic

- the learning outcomes of the I.E. 8 metal course.
- a basic knowledge of designing, drawing, cost calculation and production of a project.
- basic skills in different methods of arc and oxyacetylene welding.
- skills in the machining metals, particularly the operations involving the use of the lathe.
- skills in various forms of casting and its related areas.
- care and maintenance of equipment.

8.3.2 Supplemental

- skills in creative metal work such as enamelling, sculpture, jewellery making, and combined materials, such as plastics or wood.
- projects which involve a combination of two or more areas such as metal/electricity, metal/art, etc.

BASIC

Topic or Operation	Related Knowledge	Notes
1. Welding **Oxy-acetylene**		
Setting up oxyacetylene equipment	Safety practices Names of parts Cracking a cylinder Attaching pressure-regulator Connecting hose	The advantages and disadvantages of both acetylene and arc should be explained. Stress safety at all times.
Opening cylinder valves and adjusting regulators	Opening cylinder valves Blowing out hoses Connecting torch Safety practices Welding pressures Features and functions of regulators.	Setting up should be by demonstration only. Care should be taken to protect regulators from overpressures.
Adjusting flame	Features and functions of a welding-torch Tip sizes Tip care Lighting Types of flame	Students require close supervision on opening cylinder valves, adjusting pressures, and closing down equipment. Butt welds should be cooled in air and tested.
Shutting down apparatus	Safety precautions Closing torch valves Closing cylinder valves Draining hoses	It should be further emphasized that welds are not quenched in general practice to prevent stresses.
Heating for bending	Tip size	
Bead welding on mild steel without filler rod	Characteristics of bead welding Depth of penetration Flame adjustment Visual test	
Bead welding on mild steel using filler rod	Types of filler rods	
Butt welding mild steel	Preparation for butt welding Characteristics and uses of butt welding Tacking Testing	
Lap welding	Testing	
Fillet welding		
Cutting	Pressures required	
Hole cutting		

BASIC

Topic or Operation	**Related Knowledge**	**Notes**
2. Arc Welding		
Setting up arc welder	Safety practices	
Running bead on flat metal		Arc welding should be done only with adequate equipment.
Butt welding mild steel in horizontal position	Features and functions of A.C. welder and (or) D.C. welder	Eyes must be covered when chipping and welding. If a D.C. welder is used, provision should be made for the teaching and use of reverse polarity rods.
Lap weld mild steel in horizontal position	Rod sizes and type identification rods. Arc control.	
Fillet weld mild steel in horizontal position	Preparation of butt joint for welding Tacking Characteristics and uses of butt welding. Testing Preparation of lap-weld joint Characteristics and uses of lap welding. Testing Preparation of joint for fillet weld (v-joint). Characteristics and uses of fillet weld Testing	
Cutting steel 1/8" or less in thickness		
Cutting a hole in mild steel		
Heating for bending		
Filling holes		
3. Spot Welding	Safety Practices Types of Machines	

Topic or Operation	Related Knowledge	Notes
4. Lathework		
Squaring	Main parts of lathe	Danger of loose clothing and flying chips should be emphasized. Stress the accurate use of a scale, inside, outside, and hermaphrodite calipers. Stress should be placed upon the importance of cleanliness and the proper care of tools and machines. Chart information should be made available to the pupils when this section is being taught.
Drilling centre hole	Feature and functions of centre holes	
Turning	Rough and finish turning to a shoulder	
Tapering	Taper To micrometer sizes Cutting speeds, depth of cut, feeds Shapes of tool bits Coolants	The use of tables for conversion of linear tapers to degrees is recommended.
Chamfering	By filing, lathe files, compound rest	Reasons for rake and clearance angles should be explained to pupils. Stress the need for lubrication during the operating of the machine. Pupils should work from prepared drawings.
Knurling	Depth of cut, feed	
Drilling *Turning brass*	Twist drills Characteristics and use of brass	
Turning aluminum alloy	Characteristics and use of aluminum. Tool bit shapes	
Reaming	Allowances for reaming	
5. Handskills		
Tapping	Types of taps Lubricants, tap drills	As various materials are encountered, their manufacture and characteristics should be discussed briefly.

Topic or Operation	**Related Knowledge**	**Notes**
Threading	Types of dies Lubricants	Polishing is to be done by hand.
Laying out	Dyes, centre punches, surface gauge, dial indicator, hermaphrodite calipers, dividers	It is expected that teachers will review the applicable section of Metalwork - I.E. 8.
Filing	Thick metals, precision filing, finish filing	Discuss the surface plate and its construction. Blueprint reading should concern projects under construction.
6. Machines		
Grinder	Tool-bits, grinding angles	Stress the use of goggles, eye-shields, and the adjustment of tool-rests. Grinder construction details should be reviewed.
Drill press	Types and sizes of drills, coolants, cutting speeds, sockets and sleeves, pilot holes, drilling in alignment, drilling round stock	
Portable power drills	Types and sizes	
Power Hacksaw		
Power band saw (horizontal)		
Vertical power band saw		
Portable sabre saw		
Polishing machines	Polishing materials, buffing heads, and wire wheels	
Shaper		Simple cuts may be taught when machines are available
Milling machines		

Topic or Operation	**Related Knowledge**	**Notes**
7. Creative Metal		
Copper and Aluminum	Sheet copper, design, enameling, spinning, planishing, etching, pickling, resists Vibrator pencil, anodizing, electroplating	Use of T fittings and extra regulators to create more work stations can be considered in the welding area.
Metal sculpture		
Jewelry work		These operations are suggested only. Other facets of the metalworkers' art may be explored at the discretion of the teacher as time and facilities permit.
Combined material projects	Metal, wood, plastics, tile, glass	A variety of hard solders of varying melting temperatures are obtainable.
Enamelling		
8. Foundry		
Casting	Types of patterns and moulds Melting and pouring temperatures Degassing and cleaning Cooling and cleaning castings	Care must be exercised to assure temperature control of the molten aluminum. Use of open or closed moulds is optional for this work.
9. Forging		
Bending an eye or loop	Calculations of stock length	
Changing sections		Stress the danger of picking up work that is at a black heat. Review of Metalwork - I.E. 8 Forging is expected.
Forging low to high carbon steels		
Splitting and upsetting		
Forge welding		
10. Design and Cost Calculation	Drawings	

Topic or Operation	Related Knowledge	Notes
11. Heat Treatment		
Annealing	Safety practices	Teachers should review the Metalwork - I.E. 8 Heat Treatment section.
Normalizing	Hardening and tempering temperatures	Stress the need of adequate ventilation where poisonous salts are being used. Stress the need of tongs being dry and the wearing of proper protective clothing and goggles.
Hardening and tempering	Hardening and tempering in one heat	
Case hardening	Critical points in hardening and tempering Use of salts in heat treatment	
12. Sheet Metal Perform the following operations: *Laying out*	Safety practices Manufacture and characteristics of materials used Parallel line development Development of sloping sides with lapped or butted corners Stretch-outs	Students should be made aware of the various types of sheet metal used in industry. The Sheet Metal section of Metalwork - I.E. 8 should be reviewed.
Forming sloping sides with soldered corners		
Forming a cylinder		Various methods of obtaining stretch-outs such as pricking through, tracing from a template, or by actual drawing on the metal should be discussed.
Soft soldering		
Sweating		
Groove seam		
Use of stakes		
Wiring an edge	Wire allowances and notching for wire Review fluxes Composition of soft solder Features and functions of sheet-metal stakes Wire sizes and gauges Calculating length of wire Features and functions of sheet-metal forming machines	For types of stakes and machines refer to the revised equipment list.

Supplemental
Refer to Page 87.
Section 8.3.2

8.4 Metal 11

Intended Learning Outcomes

Upon completion the student should have expanded his or her abilities in the applications of the following:

8.4.1 Basic

- principles of the technology of the metal trades and how these principles relate to practical situations.
- fundamental skills of the allied trades of welding, sheet-metal and foundry work.
- a variety of practical exploratory experiences in the various metal fields that will help him/her appreciate related vocational opportunities.
- systematic planning and procedures and, above all, safe work habits.
- skills and knowledge in the use of lathes, milling machines, shapers and drill presses.
- skills and knowledge that will be useful in a broad field of occupations.
- care and maintenance of equipment.

BASIC

Topic or Operation	Related Knowledge	Notes
1. Handkskills		
Layout tools	Types of surface tables or plates Care and levelling of table or plate Types of parallels Care of parallels Angle plates Vee blocks Preparation of work for layout Use of dyes	The depth to which tools and their characteristics are discussed should be dependent upon time and conditions of work.
Layout instruments	Establishment of drawing reference points Dot or **prick punch** Witnessed circles and lines **Surface gauge** **Combination set** of square, centre square and protractor **Scribers** **Dividers** **Hermaphrodite calipers** **Try square** Storage of layout tools	
Vises	Types of vises Auxiliary holding devices Protection of work Care of bench vises	
Hammers	Identification by shape and weight — machinist's riveting soft faced sledge Fitting handles — wood, — plastic Balance Maintenance	Stress safety precautions when striking
Saws and hacksaws	Selection of blade Pressure required Tension required Methods of starting a cut Position of work piece Cutting speed	
Chisels, punches and drifts	Types of chisels, punches and drifts Protection of hands and eyes Selection Chipping Groove cutting Shear cutting Maintenance	

Topic or Operation	Related Knowledge	Notes
Files	Classification of files, file cards, picks and chalk Care and storage Safety precautions	
Micrometers	Care, storage, handling and reading	
Calipers	Types and features of calipers Methods of setting Work tolerances for calipers Accuracy obtainable	
Telescopic gauges	Types and features of small hole gauges Methods of transferring size Technique for setting	
Feeler gauges	Types and features of feeler gauges Methods of assembling leaves Accuracy obtainable Type of work requiring feelers	
	Types and features of radius gauges	
Screw Pitch Gauges	Reason for fillets and rounded corners	
Power hand drills, and portable machines for drilling and tapping	Types and features of portable drill machines Accuracy of work to be performed Types and features of work holding devices Capacity of portable drill motors Precautions re drill breakage Drilling at an angle to the work surface	
2. Lathework		
Construction	Parts Features and functions of parts Types of lathes Methods of control, precaution, etc. Size of lathes Safety practices prior to starting	Mathematics should not be taught in depth but should show understanding of requirements for increase or decrease in speeds.

Metal 11 - MODEL

BASIC

Topic or Operation	**Related Knowledge**	**Notes**
Care and Lubrication of the lathe	Kinds, uses and selection of lubricant Lubrication methods and procedure Frequency of lubrication Features and functions of parts Methods of cleaning — solvents, compressed air, etc. Precautions re use of compressed air Safety practices Effects of cutting compounds on the lathe Care to preserve accuracy of the lathe Methods of adjusting moving parts Quick checks for accurate alignment Tools used in making adjustment Methods of testing after adjustment	
Safety	Health, fumes, etc. Eye-sight Face-shield, goggles Clothing, smock coveralls, sweater Loose sleeves, etc. Footwear Allergy to oil	Stress safety Use Workers' Compensation Act Regulations to bolster local policy.
Lathe Accessories	Lathe centres Chucks — 3-jaw universal — 4-jaw independent -Jacobs chuck Face plates and their uses Lathe dogs Tool holders Tool bits Measuring instruments — calipers — micrometer — rule Drills — centre drill — straight and taper — shank twist drills Knurling tools Parting tool	

Metal 11 - MODEL

BASIC

Topic or Operation	**Related Knowledge**	**Notes**
Lathe Toolbits	Physical properties of toolbits Roughing and finishing tools Types of hand hones Methods of honing Methods of gauging tool angles and clearances Tools for mild steel, aluminum, cast iron and brass Principles of metal cutting	Toolbits should be considered one at a time for the type of work being done. The depth to which theory of cutting is covered will vary with conditions of class and time.
Holding work in chuck	Accuracy required Machine capacity Types of chucks Chucking procedures Pressure required to hold work Work overhang Safety practices	
Facing in lathe, — work in chuck	Selection of tool for facing Method of holding tool for facing Facing procedures Cutting speeds and feed. Maths Methods of adjusting lathe speed Methods of testing for flatness Safety practices Facing to a shoulder Methods of measuring length	
Parallel turning in chuck	Methods of holding work Selection of tool for turning Correct mounting of tool for turning Correct feed for turning Cutting speeds and feeds Positioning tool for rough and finish turning Methods of avoiding chatter Use of rocker and rocker ring Height of tool bit for cutting Position of tool holder in tee-slot Safety practices	
Dimension control	Types and features of measuring tools for length Types and features of tools for measuring diameter (calipers, micrometers, etc.) Proper use, care and storage Gauges for measuring and testing tapers Standard surface finishes	Use of measuring devices as the job requirements demand.

Topic or Operation	Related Knowledge	Notes
Drilling through holes	Methods of locating centre of of round stock: — hermaphrodite calipers — centre square — bell centre punch — self-centering in lathe Method of holding work Spotting for drilling, methods, reasons Types and specifications of centre drills Speeds and feeds for drilling Drilling lubricants Types of drills — tungsten carbide Methods of supporting drills Safety precautions	Urge use of drilling speed charts.
Drilling blind holes	Methods of controlling depth Methods of measuring and gauging depth Methods of feeding and cleaning drills Application of coolant	
Knurling in lathe	Purpose of knurling Types of knurls (pattern) Types of knurling tools Setting turning tool in lathe Lubricant for dead centre Speed of lathe Pressure Feed Proper start and finish Proper oil on knurling Knurling different metals, (Steel, cast iron, aluminum, etc.) Safety precautions	Stress safety precautions
Threading in the lathe — external N.C. thread	Types of thread: — Sharp Vee, American standard, British Standard, Unified, Acme, square buttress and other types Thread nomenclature Types of single point threading tools	Thread theory should be very general and only concepts of differences should be established. Calculation for gear trains should be very limited.

Topic or Operation	Related Knowledge	Notes
Threading in the lathe — external N.C. thread (cont'd)	Types of thread measuring tools Speeds for threading Setting compound slide for threading Depth of cut when threading Position of tools when threading Forces acting on the tool bit Side clearance of cutting tool Calculation of gear trains for threading Types of thread indicators Methods of testing and measuring threads Quick-change gear box Safety precautions	
Parting in lathe	Types of parting or grooving tools Reasons for parting or grooving Method of supporting work Speeds and feeds for parting and grooving Types of holders for parting tools Precaution re - binding Lubrication for parting and grooving	
Work on centres	Preparation of work for mounting Types of lathe centres Operating precautions (heat) Lubricants for lathe centres Methods of driving work Truing lathe centres Safety precautions Taper turning — offset tailstock method	
3. **Milling Machines**		
Construction	Care and lubrication Milling cutters and holding devices Speed feed and depth of cut Milling operations Safety	
Adjustments *— Lubrication, before starting daily, weekly* *— Installing selected*	Safety first Types, features and functions of milling machines Parts of the vertical milling machine	It is more important at this level for the student to become thoroughly familiar with the actual operation of the machine than with what makes it operate.

Topic or Operation	**Related Knowledge**	**Notes**
— Selection of speeds	Speed changing media and direction of rotation	
— Setting feed controls	Feeding mechanisms	
— Adjusting moving parts	Milling machine accessories, care and storage	
— Cleaning the machine		
Holding methods: *— Setting a vise on the work table*	Types, features and functions of vises	Deal with holding devices in detail as they are used.
— Truing the vise	Care of vises	
— Preparing the work for holding	Types, features and functions of parallel bars	
— Setting the job in the vise	Safety practices of holding methods	
— Truing the job in the vise		
Cutter selection *— End mills* *— Face mills*	Cleanliness of installation in cutter holding devices Overhang of cutter Direction of cut Depth of cut Rate of feed Length of travel Selection of coolant	
4. The Shaper *Construction* *— Lubrication*	Safety first Types, features and functions of shapers The crank shaper Parts of a crank shaper The stroke adjusting mechanism The driving mechanism Speed changing mechanism Feed mechanisms The quick return The toolhead — apron, clapper, etc. The work table The horizontal feed	— Lubrication - before starting, daily, weekly, monthly — Setting length of stroke — Positioning the ram - with or without a horizontal screw — Setting ram speeds — Setting feed controls — Adjusting moving parts — Cleaning the shaper
— The clutch - stop, start, inch	Vertical and angular down feed — and manual Shaper accessories and fixtures — care and storage	

Topic or Operation	Related Knowledge	Notes
Holding methods:		
— Setting a vise on the work table	Types, features and functions of vises	
— Truing the vise	Care of vises	
— Preparing the work for holding	Types, features and functions of parallel bars	
— Setting a job in the vise	Safety practices in holding methods	
— Truing a job in the vise		
Horizontal Shaping:	Shaper cutting tools — tool bits, - clearance and rake	
— Mounting cutters	— Right hand and left hand cutters	
— Preparation of a job	Types of tool holders	
— Setting the shaper tool-head apron	Chip control and disposal	
— Taking a horizontal cut	Feeds for roughing and finishing	
— The use of coolants	Cutting speeds and feeds — calculations Direction of feed	
— Testing flat surfaces	The horizontal cut Prevention of chatter Safety precautions Surface finishes	
Vertical shaping		
Safety		
5. Foundry *Moulding simple, flat back patterns split patterns irregular patterns - coping down*	Preparation of sand Features of moulding sand Moistening sand Tamping sand Types and features of mould boxes or flasks Forming gates and risers Location and size of gates and risers Use of parting compound Location of vents	
Heating and pouring the metal	Methods of heating Use of flux and removal of slag Correct heat for pouring Safety in handling and pouring Degassing	

Topic or Operation	Related Knowledge	Notes
Cleaning castings	Methods of removing sand Methods of removing gates and risers Dressing castings Safety precautions when machine sawing	
Safety		
6. Gas Welding		
The Oxy-acetylene Process	Discovery of acetylene Development in acetylene production Acetylene storage under pressure, fillers, acetone Manufacture of a machine to produce liquid air Discovery of the oxy-acetylene flame Introduction of blow pipes Early development of the process Development of the welding techniques Development of oxy-acetylene cutting	Stress safety aspects thoroughly
Welding gases and cylinders	Cylinder valves Oxygen cylinder pressures, size and weight General precautions in storage, handling and use Care of oxygen cylinders Oxygen production Liquid air process Commercial distribution of oxygen Manufacture of oxygen cylinders, parts, and connections, (right hand thread) Care and safety of acetylene cylinders in storage and use Acetylene from carbide Acetylene cylinders, manufacture, parts, size, connections (left hand threads)	
Equipment and accessories	Purpose of regulators Principles of operation Types: — Single stage — Two stage Comparison of acetylene and oxygen regulators, construction colour, etc.	

Topic or Operation	Related Knowledge	Notes
Equipment and accessories (cont'd)	Regulator gauges, low pressure, high pressure Installation to cylinders, precautions, care Operating precautions Working pressures General maintenance Safety practices	
	Selection of good hose, their marking, size and colour Hose connections, sizes markings, threads, left hand and right hand Clamps and ferrules Hose maintenance and care Safety practices	
	Goggles — types, lenses, etc. Gloves — clothing, boots, etc. Lighters, care, types, servicing Wrenches Mechanical accessories, table or bench types Accessories for chipping and preparation Welding rods and fluxes	
Setup and operation	Attaching oxygen regulators Attaching acetylene regulators Opening cylinder valves Connecting hose Connecting torch Testing for leaks Steps in lighting the torch and adjusting flame Steps in closing off flame Special precautions, backfire and flashback, handling of hose Proper steps in closing cylinders and draining regulators, etc. Safety rules and good practices	
Flames	Chemistry of the flame Cone, envelope and temperature Carburizing flame Neutral flame Oxidizing flame Proper adjustment and use of different flames in welding Other uses of flame: — preheating, — forming,	

Topic or Operation	Related Knowledge	Notes
	— annealing, -- flame hardening, — flame softening, — flame strengthening, — flame priming, — flame descaling, etc. Cutting flame: — preheating, — cutting, — flame gauging, — steel conditioning, etc.	
Safety	Safety rules as to clothing — inflammable or explosive material, oils, spirits, paints, etc., also rags, paper, wood, etc. Storage and transporting of welding cylinders Dangers of oil on connections Checking for leakage, recognize pungent odour of acetylene Dangers of oxygen, mixed with paints (spray) Danger of oxygen or compressed air used to ventilate confined welding quarters (inside boiler) Frozen valves and ice cylinders Fire extinguishers nearby Danger of flame to others when lighting torch	
7. Arc Welding Process		
Arc Welding Equipment and Accessories	Types of arc welders: — A.C. Machines — D.C. Machines — Combination AC - DC Cables and connections, rods, clamps, lug, etc. Table Arc helmets and shields, lenses and cover glass Chipping hammer Ball-peen hammer Try square Wire brush Tongs and pliers Chrome leather gloves with gauntlets	
Running a bead	Preparation of work Preparation of welder and booth Dangers of arc flash Safety rules	

Topic or Operation	Related Knowledge	Notes
Running a bead (cont'd)	Selection of electrode cover — flux coated rods, # 6010, 7014, 60-7014, E6012, E6013, E6020, and contact electrodes Setting current on machine Striking arc, length of arc, angle of electrode, speed of travel Crater explanation Arc blows Arc manipulation — spatter, overlap, penetration, overlay and smoothness of bead	
Types of Welds		
8. Grinding		
The Bench Grinder	Types and features of grinders Care and maintenance of machine Methods of dressing wheels Compensation laws re eye-shields, rests, etc. Dangers of exploding wheels	Stress safety to the utmost
Free hand grinding	Tool bit design Cutting principles of grinding wheel Grinding gauges for tool bits Safety practices (goggles, rests, etc.) Wheels used for high speed steels Visual identification Cooling procedures	
	Grinding carbon tool steels offhand Precaution re burning steel Tool design (chisel, centre punch angles, etc.) Methods of cooling	
Buffing	Safety practices (goggles, trailing, stress safety action, etc.) Types of compounds (greaseless and grease) Types of cloth buffs Material removal	
Belt sanding	Safety practices (goggles, fingers, stress safety, etc.) Precautions re worn and torn belts Selection of abrasive grade Mounting of belts Storing of belts Theory of rubber backing wheels Methods of forming and flattening surfaces	

Topic or Operation	Related Knowledge	Notes
9. Drills and Drilling		
Safety	Dress: — dangers of loose clothing Proper use of equipment Safe use of cutting oils	
Construction, care and lubrication	Types of drilling machines Description and name — Special features in design and construction Industrial uses of various types Features and functions of machine parts Care and maintenance — Lubrication and cleaning — Daily maintenance	
Power hand drills, and portable machines for drilling and and tapping	Types and features of portable drill machines Accuracy of work to be performed Types and features of work holding devices Capacity of portable drill motors Precautions re drill breakage Methods of drilling at an angle to the work surface	Stress safety precautions
Cutting speeds and feeds	Use of drill speed chart — Size of drill used — Material being drilled — Use of coolants	
Holding Devices	Various types and combinations of sleeves and sockets Advantages and disadvantages of the various types of drill chucks	
Work holding devices	Drill vises — types and uses Types and uses of clamps and step-blocks Safety precautions when clamping work to be drilled V-blocks	
Other machine operations: *— Boring-Counterboring* *— Countersinking* *— Spot facing*	Description and use of other operations on the drill press Types of tools and cutters used Use and care of cutters	

Topic or Operation	**Related Knowledge**	**Notes**
Other machine operations: (cont'd)	Drilling a blind hole	
	Method of controlling depth	
	Method of measuring and gauging depth	
	Types of bottoming drills	
	Method of feeding and cleaning drills	
	Application of coolants	
Drills	Use of identification of the various types	
	Description and use:	
	— spiral or straight flutes	
	— number of flutes	
	— oil grooves for deep holes	
	Parts of a drill	
	Method of enlarging a previously drilled hole	
	Importance of drilling in industry	
	Drill sizes	
	Method of drill sizing	
	— numbers	
	— letters	
	— fractional sizes	
	Drill lengths	
	— Jobber's	
	— tapered length	
Cutting action of a twist drill	Function of drill parts	
	Importance of drill point angle	
	— torsional strain	
	— end thrust	
	Effects of cutting and lip angles	
	— on material being drilled	
	Methods of measuring clearance angles	
	Effects of coolants and cutting oils	
	Use of pilot hole	
	"Drawing" a hole to centre	
	— type of chisel used	
Drill grinding	Methods of grinding	
	— freehand grinding	
	— drill grinding jigs and attachments	
	Steps to grind a drill point	
	— drill point angle	
	— length of cutting lip	
	— clearance angle	
	Effects of incorrect drill grinding	

Topic or Operation	**Related Knowledge**	**Notes**
Reaming	Hand and machine reamers Features and functions of reamers — name of parts Care and use of reamers — cutting speed — method of use — hole sizes	
	Types of reamers Use of solid reamers Expansion type reamers — limits of use Use of straight and spiral flute reamers Taper reamers: roughing and finishing Importance of cutting oils	
Tapping	Features and function of taps — part of a tap — cutting action of a tap Types of taps — characteristics and use Tap drill size — method of calculating — use of tap drill charts Tapping attachments Blind holes Method of controlling depth Types of taps Method of feeding and cleaning Application of cutting oil Precautions when using power feeds	
	Tapping troubles — breakage, chipping, torn or rough threads, and excessive wear — remedies used to correct the fault	
10. Metallurgy		
Steel	Carbon and alloy steels	
Classification of steel	Methods of naming — SAE system — AISI system Classification — low carbon steel — medium carbon steel — high carbon steel	

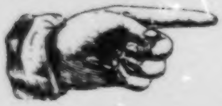
Topic or Operation	**Related Knowledge**	**Notes**
Heat treatment of steel	Structural changes with changing temperatures Heat treatment terminology: — ferrite — pearlite — cementite — austentite — eutectic (hypo and hyper) — critical temperatures Heat treatment charts Use of Iron-carbon Equilibrium diagram Use of Isothermal Transformation diagram The physical changes during: — hardening — tempering — normalizing — annealing — case hardening - carburizing - nitriding - cyaniding	
Aluminum production and manufacture	The importance of aluminum — as used in the community — as used in industry Location of ore Method of mining ore Obtaining alumina, drying and cooling Transportation, sources of power Manufacture of pure aluminum	
Aluminum alloys	Metals added to produce the great number of alloys Physical characteristics of various aluminum alloys	
Casting aluminum	Types of moulding used: — sand moulds — die casting Types of alloys available Melting point for aluminum alloys Precautions when casting aluminum	
Copper and alloys	Types and uses of Brass and Bronze Alloying elements used Types of alloys available Melting point for alloys	

Topic or Operation	Related Knowledge	Notes
	Casting precautions Percentage composition of brass and bronze alloys Physical characteristics Use in industry	
Babbitt — types and uses	Alloying elements Physical characteristics Use in industry Precautions when using molten babbett	
11. Sheet Metal *Brakes*	Deep box construction Utility tray forms Compartment construction Features and functions of a pan brake Care and use of machine Adjustment for various gauges of metal for bend allowances Layout work as required for patterns and joint construction	Sheet metal should be used in the development of patterns for fabrication in heavier gauges.
Edge treatment *Joints and seams*	Hems and wired edges Groove seams Pittsburgh locks Sheet metal variety, such as: — tin plate — galvanized iron — cold rolled sheet — aluminum from 30 gauge to 14 gauge maximum	
Spot welder	Safety practices Features, functions, and capacities	Spot welding and Oxy-acetylene welding should be used to assist in fabrication techniques applied to secondary industries.
Forming Rolls	Features and functions Safety precautions	
Rolled shapes *— cylinders* *— cones*	Use of heavy gauge metal	
Soldering	Use of soldering coppers Size of copper required for work item Use of open flame soldering Use of flux to suit work material Types and features of soft solders Types and features of hard solders Preparation of work for soldering	
Squaring, shear		
Nibbling Tools		

Topic or Operation	Related Knowledge	Notes
12. Pipework		
Cutting	Types of pipe and fittings	An understanding of water installations in the home should be covered regardless of the type of piping.
Threading pipe	Thread forms Threading tools — die heads, etc. Cutting lubricants Pipe volume flow	
Flaring tubing	Single flare Types of fittings — sleeves — pressure	
Cutting, fitting and sweating copper pipe and fittings	Cleaning Soft soldering Fluxes Hard soldering Hard and soft drawn pipe sizes	
Test assemblies	Pressure effects on joints	
Plastic Tubing	PVC ABS	
Conduit	EMT Rigid	

8.5 Metal 12

Intended Learning Outcomes



Upon completion the student should have expanded his or her abilities in the applications of the following:

8.5.1 Basic

- the learning outcomes of the Metal 11 course.
- in-depth knowledge of one or more of the metal areas.
- working knowledge of metallurgy, alloying of metal and the processing of metal from the raw to finished stage.
- newer machine methods of processing, such as Electrical Discharge, Numerical Control, Tungsten Inert-gas (T.I.G.) and Metal Inert-gas (M.I.G.) welding.
- safety consciousness and good work habits.
- the vocational opportunities available in metal trades.
- care and maintenance of equipment.

BASIC

Topic or Operation	Related Knowledge	Notes
1. Handskills *Layout*	Types of keys and KEYWAYS Procedure for layout use of keyseat rule Use of centre square Size and depth of keyseat Review of layout procedures	
— Layout tools	Layout preparation of castings or steel plate Use of whiting solution and dyes	
— Layout instruments	Level protractor and angular division The use of Vernier scales Use of prepared math tables Layout geometry of standard shapes and division Trammels Templates Straight edges The layout of holes Geometric layout Setting dividers from verniers Setting protractors Testing hole locations	
Scrapers and scraping	Types of scrapers Use of scrapers Testing scraped surfaces	
Measuring *— Reading micrometers*	The micrometer 1/10,000th and metric, and adjusting micro-meters Checking problems of transferring size Care, storage and handling Digital micrometers	
— Reading Vernier scale instruments	Types and features of vernier scales Reading verniers Correct "feel" when measuring Digital verniers	
— Outside and inside micro-meters	Types and features of inside micrometers Extension standards Precautions in cleaning for assembly "Rocking" technique for inside setting Transferring sizes	

Topic or Operation	Related Knowledge	Notes
— *Dial indicator*	Types and features of dial gauges Mechanical principles of dial gauges Types of dial faces Accessories Scope of work Care of storage	
Drills and Drilling — *Drill jigs and fixtures*	Types, features and functions of drill jigs Care and storage of jigs Types and fixture of clamps Care and storage of special bolts Care in mating parts and cleanliness	
2. Lathework		
Safety — *Good Housekeeping*	Replacement of tools and accessories Dispose of oily rags Types of disposal equipment Routine cleaning Scrap disposal Use of safety equipment	
Adjustments	Methods of adjusting moving parts Allowance for fit in stationary and moving parts	
	Types and limitations of TAPER ATTACHMENTS Method of calculating tapers Methods of mounting work Methods of testing work	
General lathe operation	Use of steady rest Use of follow rest Use of crotch centre Use of drill pad in the lathe Large face plate work and use of angle plate Use of tool post grinder Review of thread cutting, left and right hand threads Free hand turning Use of radius gauge Machining stepped vee pulleys Accurate set up and checking with dial indicator Gear ratio Spindle and stud gear ratio, for simple and compound gearing (math).	Principles of gearing are required. Tool post grinder operations may be required for maintenance of lathe centres and tool sharpening as required. Left hand thread cutting should be used if possible.

Topic or Operation	Related Knowledge	Notes
Threading	Speeds for threading	
	Screw thread standards and their application	
	Thread forms and general dimensions	
	Classification of fits	
	Types of internal threading tools	Thread forms should be discussed in general, depth of study should not be too great.
	Positions of tools	
	Direction of feed	
	Tool setting gauges	
	Preparation of work for threading measuring internal threads	
	Precautions, tool clearance	
	Cutting, testing, gauging and measuring	
	Internal taper threads	
Boring	Types of boring bars, head and tools	
	Mounting tools	
	Cutting speeds and feeds for boring (Maths)	
	Cutting lubricants for boring	
	Measuring bores	
	Types of measuring tools	
	Chip control	
	Surface finishes	
	Size of boring bar	
	Precaution, re chatter	
	Safety practices	
	Tool bit design	
	Depth control and measurement	
	Chip control and disposal	
	Safety precautions, bottoming	
Contour turning	Free hand forming	
	Templates	
	Types of forming tools	
	Application of contour plates	
	Traced points	
	Testing contours	
	Finishing formed work	
Eccentric turning	Mounting and offsetting work	
	Calculation and Measuring offset	
	Types and uses of throw blocks	
	Speeds for eccentric turning	
	Methods of preventing spring	
	Types and uses of reach over tools posts	
	Safety practice, speed throughout, etc.	

Topic or Operation	Related Knowledge	Notes
Work on Mandrel	Types of mandrels Use and care of mandrels Testing mandrels for accuracy Mounting work Precaution re lubrication of mandrel Driving mandrel Measuring work on mandrel Removing work from mandrel Precaution — re damage to mandrel	
Parallel and taper turning between centres on a mandrel	Alignment of tailstock Selection of proper cutting tool Proper tool holder and location Cutting speeds and feeds Measuring diameter Control mechanism of lathe Carriage for correct depth of cut required.	
	Types of cutaway centres Position of tool for rough and finish turning Hand and automatic feed Turning to a shoulder Use of compound slide for tapers Finish on surface Safety and precautions	
Precision lathe work to close tolerance	Machine different fits, push, driving, press, shrink, etc. Machining small holes to close tolerance using telescopic gauges Use of inside micrometer for large holes Precision machining using Vernier micrometer Use of snap ring gauges, go - no go Accurate boring using Vernier height gauge Use of Vernier level for measuring angles Eccentric turning and method of measuring offset Use of Carbide cutting tools	
Lathe cutters	Types — forged, standard (carbide, ceramic) Sizes and material of cutters Grinding tool bits, (carbide grinder optional) Suitable grinding for steels, cast iron, ductile iron, aluminum, plastic, copper	

Topic or Operation	Related Knowledge	Notes
Lathe cutters (cont'd)	Inclined slot and straight slot in tool holders Methods of holding cutting tool Safety precautions when installing and while in use	
Threading in the latne	Calculating change - gears for cutting screw threads	
Reaming in the lathe	Reasons for, and types of, reamers Gear trains: simple or compound Reaming allowances Chip and chatter control Lubricants for reaming Speeds and feeds for reaming Measuring and gauging Handling and storing reamers Safety practices when reaming	
3. Milling Machine		
Safety		
Attachments and Fixtures	Footstock Types, features and functions of vises, index head and dead centre Adjustment for angles Rapid and simple indexing	See safety notes throughout.
Milling Operations	Flat surfaces Vertical Angular Keyways Slots Indexed surfaces	Calculations as required for various operations depending upon cutter selection.
Horizontal and Vertical Milling		
4. The Shaper		
Safety		See safety notes throughout
Shaper Operations	Tool design for shaping vertical and angular surfaces.	
Vertical, angular, curved and irregular cuts.	Testing angular work	Safety precautions re clearance of the toolhead when set at an angle.
Serrating	Reasons for serrating Tool design for serrating Design of serrations — square, diamond	

Topic or Operation	**Related Knowledge**	**Notes**
Grooves, index centres	Preparation of the work Grinding forming tools Roughing cuts Finishing cuts Using forged forming tools Measuring and inspecting curved surfaces — templates, etc., coolants Speeds and feeds Correction of tool chatter Surface finishes Laying out techniques Setting up cutters — internal and external cutters Setting stroke for blind grooves Measuring depths Chip disposal Shaping a tongue and groove Types and uses of grooves; e.g., keyways Testing and measuring tools Standards of keyways Types and features of cutters Speeds and feeds for grooving Precautions about tool breakage Safety precautions	Impress safety precautions
5. Foundry Practice *Safety*		
Foundry practice	Types and features of patterns used in sand casting Materials used to make patterns Split patterns Draw on patterns Fillets on patterns Patterns with core prints Colour identification of surfaces Providing for shrinkage Core boxes Machining allowances Flasks	The depth of pattern making will vary with work requirements
Preparing cores	Types and features of cores Preparation of core sand Bonding material Finishing cores after baking Locating cores in the mould Preventing core sag and shift Venting for cores Removing cores from castings	Cores may be baked in a tin oven over a soldering furnace.

Topic or Operation	Related Knowledge	Notes
Heating and pouring metals	Safety in pouring molten metal Types of metal for casting — aluminum, brass, cast iron and steel The use of flux for cleaning molten metal (degassing).	Aluminum is a good metal to use in foundry practice. The other metals should be discussed in general only.
Cleaning castings	Commercial cleaning methods Commercial dressing methods	
Die Casting		
6. Welding *Oxy-Acetylene Welding*		
Safety		
Equipment and Accessories	Construction and operation of welding blowpipes Classification of welding blowpipes — injector type, medium, — pressure type Interchangeable heads or tubes, sizes, care, cleaning, etc. Construction of cutting blowpipes Types of cutting blowpipes, injector type, medium pressure type. Interchangeable nozzles or tips, types, sizes, use, care Blowpipes for specialized service	
Identification of metals	By: Use Appearance Chip test Spark test Blowpipe test	Theory of metal properties is an important factor in the work of a welder and a good understanding of these topics is important.
Preparation for welding	Principles of joint design Joints in sheet metal Butt weld, flange weld, lap weld Joint in plate material Open, square butt weld Open single vee, open double vee Open vee groove Preparation of edges Cleaning, alignment, preheating Sequence of operation	

Topic or Operation	Related Knowledge	Notes
Expansion and contraction	General theory of expansion and contraction Expansion in sheet metal Upsetting Principles of jigging Expansion and contraction for straightening, shrinkage Expansion and contraction on restrained parts Expansion and contraction stresses Co-efficient of Thermal expansion Heat conductivity Co-efficient of Thermal conductivity	
Welding Operations	— Butt joint — Lap joint — Fillet welds — Corner weld — Vertical welding on butt joint, lap joint, and fillet welds Material — mild steel	Welding skills must be ably demonstrated before techniques are employed in repairs or used in the course of the program.
Manual Flame *— cutting operations* *— cutting heavy steel plate* *— cutting holes* *— bevelling* *— cutting rivets* *— pipe cutting* *Radial cutting* *Steel block cutting and heavy sections* *Gauging* *Cutting cast iron — Optional*	Preparation and procedure for steel Preheating methods Use of oxygen lance Preventing cracks and checks Blowpipe manipulation, tolerance	
7. Arc Welding *Safety*		
Electrode selection	Electrode length Core wire diameter Melting rate Depth of penetration Type of coating China clay, silica, mica, etc. Potassium Feldspar, Potassium Titanate, etc.	Welding theory should be given to make the subject effective but the practice on machines should be predominant.

Topic or Operation	Related Knowledge	Notes
Electrode Seclection (cont'd)	Cellulose	
	Ferro manganese	
	Iron oxides	
	Water, Glass (Sodium Silicate)	
	Weight of coating	
	Purpose of coating	
	Methods of coating electrode	
	Ease of operation	
	Current density	
	Ease of striking and restriking	
	Poor fit up	
	Current type	
	Slag removal	
	Overhead usability	
	Vertical up	
	Vertical down	
	Thickness of metal being welded	
	Weld quality	
	Soundness	
	Bead appearance	
	Bead contour	
	Spatter loss	
	Current capacity	
	Flux to steel ratio	
	Deposition rate	
	Deposition efficience	
	Type of machine being used	
	Butile	
	Arc stabilizer	
	Deoxidizers	
	Slag formers	
	Protective gas producers	
	Alloy additions	
	Liquid binders	
	Sulcoated rods	
	Rolled electrodes	
	Dipped steel electrodes	
	Extruded coating	
Classification and Identification of Electrode	Code W 48 breakdown	
	Primary and secondary colour markings	
	Bare electrodes	
Welding Problems	Welder generating but current falls off when welding	
	Welder starts but will not deliver welding current	
	Welder runs but soon stops	
	Welding arc is loud and spatters excessively	

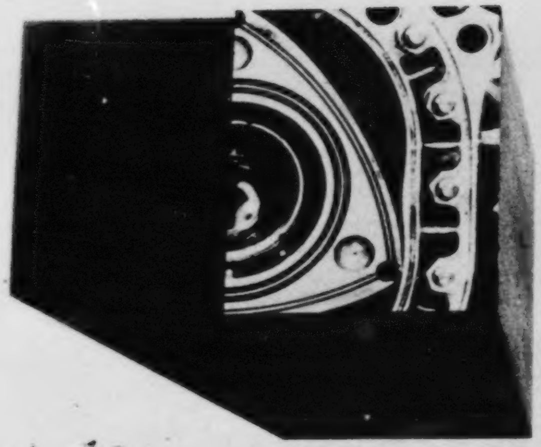
Topic or Operation	Related Knowledge	Notes
	Starter operates and blows fuse Welding arc sluggish Touching set gives shock Generator control fails to vary current	
Welding Operations	On flat surface — Butt weld — Lap weld — Fillet welds — Corner welds — Testing of welds	
	On vertical surface — vertical butt joint — vertical lap joint — vertical fillet welds — vertical corner weld Theory of puddle holding and penetration of weld	
8. Grinding *Safety*		
Wheel selection	Grinding wheel codes and markings Resting wheels before mounting Care and storage of wheels Theory of arbours and correctly mounted wheels Safety practices — re cracked wheels, R.P.M., etc.	
Mounting wheels	Methods of testing wheels before mounting	
Types of grinding	Bench grinders Tool and Cutter Grinders Surface grinders Tool post grinders Portable grinders	
9. Power Saw *Safety*	Safety practices	
Types of Saws	Care and maintenance of machine Cutting speeds	
Cutting off stock shapes	Precautions — re length of work in vise. Types and use of coolants	

Topic or Operation	**Related Knowledge**	**Notes**
Cutting off stock shapes (cont'd)	Blade selection Cutting principles Minimum and Maximum work size	
	Precautions Work holding techniques Vertical standing band saw table	
10. Metallurgy *Metallurgy — irons, steels, copper and its alloys aluminum and its alloys nickel and its alloys leads and zincs*	Understanding the need for Metal Technology Atoms and their behaviour in metals Microstructure of metals — grain growth — position of atoms; face centered and body centered cubic	
	Factors determining the properties of metals Tensile strength Yield point Ductility	
	Identification of metals Standard shop tests — fracture test — workability — ring test (sound when dropped)	
	Spark test for ferrous metals Use of known specimens Reaction of metal with the grinding wheel to produce the different types of spark Identification of sparks	
	The production and manufacture of iron Raw materials required — limestone — iron ore — coal — hot air	
	Methods of mining (open pit, shaft) and locations of iron ore Methods of transportation Methods of mining and location of limestone deposits Manufacturing coke from coal Method of heating air for the blast furnace	

Topic or Operation	**Related Knowledge**	**Notes**
	Types of iron ore Physical identification of iron ore Types of iron ore used — hematite — magnetite — limonite	
	Blast Furnace Description Description of physical feature: — construction of blast furnace — importance of stoves Raw materials required Chemical reaction of the raw materials in the blast furnace End products, use of — pig iron — slag	
	Types and Uses of Cast Iron: Operation and description of a Cupola type furnace Characteristics and use of — grey cast iron — white cast iron — maleable cast iron — Meehanite	
	Steelmaking — method used: Phosphorous, the determining element — basic method — acid method	
	Types of Basic Furnaces — open hearth — electric Importance of regenerative type furnace — Wm. Seimen Advantages and operation of the open hearth furnace Advantages and use of electric furnace	
Steelmaking	Types of acid furnaces — Bessemer Convertor — Oxygen Lance furnace — Electric Speed of production of this type of furnace Disadvantages of acid furnaces Characteristic of metal produced Inventors of Convertor: — Bessemer and Kelly	

Topic or Operation	**Related Knowledge**	**Notes**
Steelmaking (cont'd)	Induction type electric furnace: Type of steel produced Advantages and disadvantages — controlled atmosphere — cost	
	Flow Chart for Steelmaking Follow the operations from a chart Understand and describe each operation Types of rolls and products — billets — slabs — blooms	
Colour Coding for Steel	Check Canadian Standards Association pamphlet	
Effects of Alloying	Alloying elements Metals used for alloying elements Effects and results of the alloying elements on carbon tool steel	
	Effects of alloying on heat treatment Understanding of: — water quench — oil quench — air quench	
Specification details of alloys	To be able to read and understand specification details, charts, and heat treatment instructions	
11. New Machines *Numerical control*		
Universal Grinder		
Electrical Discharge		
12. Punch Press *Safety*	Safety precautions	
(Option) where press is available	Features and functions of small press Allowances for die work	
Punch press operations	Procedures for punch work Design of dies	

MECHANICS



9. MECHANICS

9.1 Introductory Statements

9.1.1 The instructor must ensure that safety practices are first in importance, both generally and with specific regard to the hazards in the mechanics shop.

9.1.2 The instructor should create an atmosphere in the shop of respect for the care, use and storage of equipment.

9.1.3 Because of the nature of the subject, it is suggested that time blocks be expanded in the senior years to allow for more extensive practical work.

9.1.4 In planning courses, the following guidelines, with respect to the balance between theory and practical experience, are suggested:

— 9/10 level should be 70% practical and 30% related theory;

— 11 level should be 80% practical and 20% related theory;

— 12 level should be 90% practical and 10% related theory.

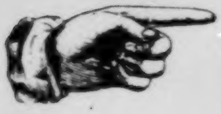
9.1.5 The instructor should promote enrichment situations at each level after the learnings of that level have been mastered.

9.1.6 To allow for students with varying I.E. experiences, the instructor must use his discretion when organizing the Mechanics 11 class.

9.1.7 Because of the nature of the mechanics course the instructor must remember that the acceptable standard for proficiency in practical work must aim at 100%. Anything less could lead to serious injury.

9.1.8 Mechanics is a practical course involving large pieces of equipment in a confined space. In order to make the maximum use of the time available, the instructor should assign the students to dispersed work stations.

9.2 I.E. 9/10 - mechanics



Intended Learning Outcomes

Upon completion, the student should be competent and confident in the application of the following:

9.2.1 Basic

- systematic and logical procedures in thought and practice.
- a degree of proficiency towards hand skills, tolerances and measurement.
- maintenance and operation of basic hand and power tools related to the course.
- basic theory of operation of the two and four-stroke cycle engines.
- disassembly, inspection and successful reassembly of a small internal combustion engine.
- basic knowledge of present and possible future energy sources.
- basic planned preventive maintenance on the automobile; e.g., grease job, oil change, spark plug change, air, fuel and oil filter change and tire rotation.
- care and maintenance of equipment.

BASIC

Topic or Operation	Related Knowledge	Notes
1. Sources of Power *Heat Engines*	Two types: External combustion: Steam — piston and turbine Uses — ships, trains, generators	Types may be demonstrated by diagram or pictorial material.
	Internal combustion: Gas engine Diesel engine Gas turbine Jet engine Rockets Uses — cars, trains, boats, aeroplanes, space research	A research project on the origin of various types and limitations may be undertaken by pupils.
Electric Motors and Generators	Motors — Two types: Alternating current — Household uses — Light industrial	Demonstration by the teacher or a research project by the pupils is suggested as an activity for this section.
	Direct current: — Heavy industrial — Transportation	
	Generators — two types: Direct current — Most common in engines — Various types	Pupils should be responsible for part names. The elementary magnetic theory should be demonstrated.
	Alternating current — Alternators — Rectifiers — germanium, silenium, diodes, and silicon	Safety practices in handling alternators and battery charging are to be taught.
2. Threads and Threading *Threads*	Purpose: Acts as a fastener Allows adjustment Transmits power	Drawing of thread forms may be used to show basic differences.
	Types: Unified National Coarse Unified National Fine Whitworth Metric	
Tools for making threads	Taps: Taper Plug Bottoming	The use of taps and dies in making or repairing projects should be taught when applicable.

BASIC

Topic or Operation	Related Knowledge	Notes
	Dies: Solid Adjustable Care and cleaning	
	Screw extractors — use, drill size, direction of rotation	
Fasteners	Screw type: Cap screws Nut, bolt, and flat washer Studs Machine screws Self-tapping screws	Sketches of screw fasteners on prepared sheets will aid instruction. Tightening sequences should be noted. Torque capacities of various bolt sizes should be available for reference: e.g. 1/4", 15-20 foot-pounds; 3/16", 20-35 foot-pounds; 3/8", 35-50 foot-pounds; 7/16", 50-80 foot-pounds; 1/2", 80-100 foot-pounds. Sketches of various screw head types on prepared sheets would be valuable teaching aids for this section.
	Head types of screw fasteners Flat Round Oval Fillister Hexagon Alien — internal hexagonal Fluted Phillips Clutch Reed and Prince	
	Rivets Solid Tubular Split	
Locking Devices	Nuts Castellated self-locking, fibre fibre core Palnuts, con-rod locks	Applications of all locking devices should be stressed throughout the course.
	Washers Spring — split and solid Star — internal and external Special — lug locks	
	Keys Woodruff Straight Cotter pins Taper pins	

Topic or Operation	Related Knowledge	Notes
3. Tools and their use *Wrenches and Accessories*	Sockets — Shallow, deep, and flexible Hexagonal — 6-point Double hexagonal — 12-point Double square — 8-point	Sockets should be used in preference to other types of wrenches, where physical conditions permit. Use double square sockets if farm machinery is to be used for instruction. Demonstrate the correct use of wrenches as applicable.
	Drives Midget, 1/4". Ferret, 3/8". Standard, 1/2". Heavy duty, 3/4".	
	Handles Speed Flex-bar T-bar Ratchet Torque	
	Box end — used where sockets are not applicable.	
	Open end — used only where others cannot be used	
	Combination — provides versatility	
	Adjustable — very limited use	
	Special — spark plugs, flare nuts	
	Torque Wrenches — care and use of torque wrenches	
Screw-Drivers	Types: Straight blade Phillips Special	Avoid the use of a screw-driver as punch, pry, or chisel.
Hammers	Types: Ball-peen Soft face or brass drift Rubber	Safety practices must be taught. Stress the need for a flat strike when using ball-peen hammers. It is suggested that a prepared sheet showing tools be used as a research assignment to assist pupils in learning correct trade terminology.

BASIC

Topic or Operation	Related Knowledge	Notes
Pliers	Types: General purpose, combination Flat nose, side cutting Diagonal cutters Needle nose, side cutting Diagonal cutters Needle nose, side cutting Special — water pump.	
Chisels	Types: Flat Cape Round nose Diamond point	Maintenance and safety practice are to be taught.
Punches	Types Centre Pin or starter Drift, tapered	
Files	Types: Flat — grades and identification Half-round Round Rat-tail Special	Cleaning and maintenance are to be taught or reviewed.
Hacksaw	Blade types and uses — hardness, teeth per inch	Selection of the correct blade for the job should be stressed.
Measuring Devices	Feeler gauges Flat blade, valves Wire, plugs	
	Calipers — inside and outside	
	Micrometers — how to read and use meters Inside Outside Dial	Calculations required for micrometer readings could be prepared as a lesson aid.
4. Internal Combustion Engine — Piston Type		
Principles of Operation	Four-stroke cycle, two-stroke cycle	Demonstrate the procedures for stripping, cleaning and assembly of engines. Note the torque capacities of bolts.

Topic or Operation	Related Knowledge	Notes
Parts and Function	Parts: Cylinder Piston Rings Crankshaft Connecting rod Wrist pin Valves Flywheel Head	Demonstrate the various valve arrangements — "L" arrangements, "I" arrangement, "F" arrangement, "T" arrangement.
Operation of Engines	Starting engines Adjustment of engines during operation Starting systems: Rope Ratchet or kick Rewind Inertia Electric Operating maintenance Spark plugs Lubrication Routine cleaning	At this point it is practical to proceed with team or individual assignments on engine stripping and assembly. Start and finish the assignments with an operating engine.
	Stopping engines Short shutdown Long shutdown	Safety practices in storing fuels and solvents should be taught with this section.
5. Fuels and Fuel Systems		
Fuel	Story of petroleum Petroleum tree diagram Distillation process Gasolines Diesel fuel	Diagrams of products and processes would be useful as lesson aids.
Carburetion	Bernouille's principle (Venturi) Carburetor circuits Float High speed Low speed (idle) Choke	Circuits and parts may be best taught by stripping and reassembling carburetors.
	Two additional circuits in large carburetors may be added if desired, but do not apply to small engines Power enrichment Accelerator	Sectional drawings of parts or circuits would be valuable lesson aids.

Topic or Operation	Related Knowledge	Notes
Fuel Pumps	Gravity feed, pressure differential Pump feed (diaphragm) Mechanical pumps Electric pumps — pulse type (magnetic)	Pupils should strip the pumps and identify the parts and the action. Sectional sketch of fuel path would be a valuable reference.
Fuel Tanks	Various types of tanks and lines Location — type of feed Construction — venting, baffles Fuel gauges Fuel-lines	Safety practices for repairing a gas tank should be stressed.
6. Electrical Systems		
Magnetic Theory	Bar and horseshoe magnets. Two types — natural and artificial Electromagnets Coils Magnetos Generators Motor Induction by A.C. Induction by interrupted D.C.	Teachers should plan to demonstrate the various types. The review of parallel circuits Unit 1 (electricity) may be sufficient for this section.
Ignition System	Names and functions of parts	
	Primary circuit Battery — Power source — Chemical action Coil — primary winding Contact points Condenser Ignition switch Cam — mechanical switch Secondary circuit Coil — secondary winding Rotor Distributor cap High-tension leads Spark plugs — Different types — Heat ranges — Cleaning — Gapping	Servicing, charging, and testing batteries should be part of the instruction. Safety precautions must be taught: e.g., charger AC lead is disconnected before the leads to battery, gassing in enclosed areas could lead to explosions. Cleaning and gapping plugs are to be taught. A section drawing of a coil would be a useful teaching aid. Students should learn to use a timing light and make minor tuneups.

Topic or Operation	Related Knowledge	Notes
Magnetos	Flywheel magneto Armature Coil Points and condenser Cam action Maverick spark — 4-cycle	Stripping and reassembly of the magneto would assist the students in learning the various parts.
	Horseshoe permanent magnet Construction Applications	
Electrical Circuits	Wiring and accessories diagrams. Circuit-tracing — colour codes	Wiring diagrams, ignition boards, lighting boards, and circuit boards would be valuable teaching aids. Also refer to Unit 1 (electricity).
7. Lubrication *Sources of Lubrication*	Oil Five functions of oil: — Lubricates — Cools — Seals — Scavenges — Hydro static shim Grades, viscosity, and service	A petroleum chart or sample-board would be useful for pupil reference. Oil changes and lubrication of cars and engines should be undertaken by pupils.
	Greases — soda base, calcium base, aluminum base.	
	Gear lubricants — plain, hypoid (E.P.)	
Systems	Gravity — drip oiling — limited	
	Splash — con-rod dip — small engines	
	Pressure — automotive	
Pumps	Plunger pumps Gear pumps Rotary pumps	Stripping and reassembly of pumps will assist pupils to learn parts. Flow diagrams of the crankshaft would be valuable reference.
Filters	General construction Full flow By-pass	Discuss various applications and the functions of relief valves in this lesson.
	Function and maintenance	Pupils should undertake the changing of filters.

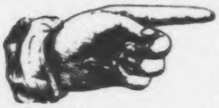
Topic or Operation	Related Knowledge	Notes
8. Bearings		
Bearings		A bearing as a friction-reducing device is designed to support loads and reduce wear
Types of Load	Sectional views of bearing types showing structure and load factors are valuable references.	Radial Thrust Combination
Types of Bearings	Removing and replacing sleeve bearings, fittings, and reaming lubrication should be part of the instruction.	Friction of sliding contact Plain bushing — bronze sleeve, nylon sleeve Flat thrust — bronze washer End play — clearance
	Pupils should remove and replace ball or roller bearings. Stress the precautions necessary in fitting, pre-loading, and lubrication.	Anti-friction or rolling contact Annular ball Ball thrust Cup and cone Straight roller Tapered roller
Applications		Friction, e.g.: Generator bushings Small-engine main bearing Wrist-pin bushings Split inserts or shells
	Pupils should clean, pack, and adjust front-wheel bearings on a car or a front-end training unit.	Anti-friction, e.g.: Generator bearings Clutch throw-out Wheel bearings (cup and cone). Wheel bearings (roller). Universal joints
9. Power Transmission		
Drives	The formula for calculation of pulley ratios is to be taught: SXD = s x d.	Types: Friction — pulleys and clutches Belt and pulley — V-belt, flat belt, link belt, toothed belt Chain and sprocket — roller chain, toothed chain Gear — spur, helical, herring bone Shaft and universal — single, compound Fluid — fluid couplings, torque converter

Topic or Operation	Related Knowledge	Notes
Clutches	Types: Friction — Automotive disk — Centrifugal drum Fluid — fluid coupling	Remove and replace automotive clutch or repair chain-saw clutch would be suggested experiences for pupils.
Transmissions	Types: Belt and pulley — lathe, washing-machine Chain and sprocket — bicycle Sliding gear — standard automotive Planetary gear — automatic automotive	Teach the purposes of a transmission: — Increase or decrease ratio. — Change direction of rotation — Act as a torque converter. Problems in gearing, direction of rotation, and ratios should be included in this section. Repair and installation of belts will assist pupils in identifying belts and pulleys. Teachers should demonstrate a standard automotive transmission.
Differential Assembly	The purpose of a differential assembly Types: Conventional Limited slip	Note that a differential allows for an increase or decrease in gear ratio and for differential rotation. Demonstration of a conventional differential assembly is suggested.
10. Hydraulics *Pascal's Law: When pressure is applied to a confined fluid, it is transmitted undiminished throughout the fluid*	Definitions Pressure: Force = pounds per square inch. Area Force: Pressure X area = pounds Work: Force X distance = foot-pounds Application — master and slave cylinders: — Transfer of motion — brakes — Increase of force — hydraulic jack Change direction of motion or force — steering	Problems in calculation of pressure, force, and work should be an integral part of this section. A master and slave unit mounted on board for pupil reference is suggested. Filing, bleeding, and adjusting brakes should be done by pupils. Master- and wheel-cylinder stripping and assembly of the brakes will assist the pupils in learning parts. Discussion of the advantages, disadvantages, and various applications is suggested. Pupils should be expected to identify primary and secondary brake shoes. Installation, adjusting, and bleeding of cylinders should be done by the pupils.

BASIC

Topic or Operation	Related Knowledge	Notes
Hydraulic Brakes	Purpose of brakes Types: Huck Bendix (Duo-Servo) Wagner Lockheed Disk	
Brake Linings	Two main types: Rivetted Bonded	
	Cooling of brakes — structure of drums, structure of linings	

9.3 Mechanics 11

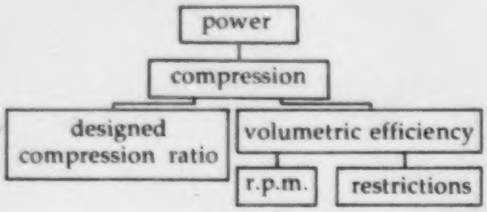


Intended Learning Outcomes

Upon completion the student should have expanded his or her abilities in the applications of the following:

9.3.1 Basic

- logical thought and procedure leading to a diagnostic approach.
- a positive attitude towards the importance of precision measurement as it relates to the automobile.
- good practices in the cleanliness and maintenance of the mechanics workshop.
- the need for, and use of, automotive shop manuals and manufacturers' specifications.
- the function and use of basic equipment such as tach-dwell meter, power timing light, volt and ampere meters, etc., as will be used in the planned maintenance of the automobile.
- knowledge of the engine and power train of the automobile, including front end wheel alignment, steering and brakes, with as much practical exposure as possible.
- basics of good mechanical design and available alternative power units as they apply to the automobile.
- automotive parts and ordering procedures.
- care and maintenance of equipment.

Topic or Operation	Related Knowledge	Notes
1. Review of Engine Principles	4 stroke cycle 2 stroke cycle power theory  power compression designed compression ratio volumetric efficiency r.p.m. restrictions	Placing hop up techniques such as, planing heads, performance cam shafts, headers, additional carburetors, etc., on the diagram, provides a contemporary way to demonstrate the theoretical concept.
Engine Components	Block	Cylinder gauging, taper, removing ridge, honing.
	Pistons	Split skirt, cam grounds.
	Crankshaft	Check for wear, undersize, out of round, taper.
	Connecting rods	3 piston pin connections.
		Con rod bearings, material
	Valve train	Camshaft, cam followers, push rods Valve mechanisms, valve reconditioning, use of valve refacer and reseater, valve adjustment
Cylinder Numbering Patterns	4 cylinder 6 cylinder V-8	Service data
	Firing orders	Service data
	Balance order	Setting valves, timing.
Three things required for operating Combustion	Air fuel mixture — carburetion	6 basic circuits Disassembly and inspection Air fuel ratios
	Compression — diagnosis from wet and dry readings	
	Ignition — diagram — function of coil, (theory of induction), contact points, condenser, ballast resistors, distributor cap, rotor, leads, and spark plugs.	Charts, mock-ups, on engine service audio-visual material.

The inspection and service of items 1-2-3, constitute a major tune-up. Students should be instructed in the use and care of each piece of tune-up equipment. They should also be encouraged to reason out problems — diagnose — on the basis of their theoretical knowledge and on the results of readings of the test equipment.

Topic or Operation	Related Knowledge	Notes
2. Engine Lubrication Unit	Functions of oil Types of oil pumps Strainers and filters Pressure relief valves Oil circuitry Gauges and indicator lights Classification of oils Additives	Oil company pamphlets Chapter 35 — Automotive Tech. Properties of oils e.g. viscosity, anit-foam, detergency, anti-oxidation, etc.
3. Cooling Systems Unit	Water jackets Radiator or heat exchanger Circulation Thermostats — bellows — sliding cylinder or pellet type Pressure caps Sealed coolants Antifreeze Heat absorbtion characteristics as they are influenced by pressure and by change of state Air cooling — fins — shrouds	Sample cores from radiator shops, cut-away water pump and sample thermostats help in visualizing this unit.
4. Electrical Wiring Unit	Series and parallel circuits Headlights — prefocus — sealed beam — quartz iodide — adjustment (aiming) Brake lights Brake light switches — mechanical — hydraulic Relays Accessories Fuses and circuit breakers Ground connections Wire sizes Turning signals — flashers Reading schematic wiring diagrams	A lighting display board capable of being re-wired as an assignment is a useful teaching device.

In addition to the shop activities outlined, there should also be a series of ongoing shop activities related to the planned maintenance of the automobile, which could start right at the beginning of the term. A sample list is offered as a guide only.

Topic or Operation	**Related Knowledge**	**Notes**
5. Planned Maintenance		
Battery	Use of jumper cables	Alternator equipped vehicles
	Battery disconnect and connect sequences to avoid shorting out with wrenches	
	Testing	Voltmeter, hydrometer Surface charge
	Cleaning terminals and case	Voltmeter
	Check cables and connections	Hydrogen gas
	Recharging procedures	
Lubrication	Lube charts	Record mileage and date
Oil change	Specified oils	Record mileage and date
	Oil filter	
	Dilution tests	
	Flushing	
Wheel bearings	Cleaning techniques	Caution on use of compressed air
	Visual inspection of bearings	
	Repacking techniques	
	Preload adjustment	
	Seals	
Brakes	Checking fluid levels	
	Checking lines and hoses	
	Visual inspection of linings, wheel cylinders and brake drums or rotor	Caution when blowing asbestos dust.
	Brake adjustment	
	Bleeding	
Cooling system	Anti-freeze test	
	Pressure test	
	Pressure cap	Caution on removal when hot.
	Hoses and clamps	
	Flushing	
	Thermostat	
	Water pump	
	Fan belt	
Fuel system	Fuel pump tests	
	Fuel filters	
	Sediment bowls	
Check lists	Fan belt — adjustment	
	Air filters	
	Crankcase ventilator valves	
	Oil leaks	

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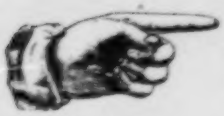


Intended Learning Outcomes

Upon completion the student should have expanded his or her abilities in the applications of the following:

9.4.1 Basic

- analytical and critical thought patterns toward mechanical problem solving.
- operation and repair of the automotive auxiliary systems such as electrical fuel, lubrication and cooling.
- overhaul procedures of major automotive components, and to experience as much practical work as possible.
- operation and care of equipment available in the mechanics workshop.
- the student should grow in awareness of the vital importance of conservation of non-renewable resources in general, and with particular reference to the effect of automobile pollution and the use of controls.
- recent developments in the automotive repair industry, e.g. unit replacement of parts.
- competency that will enable the student to determine his or her desire to work in the automotive field, or to further his or her training in related areas.
- care and maintenance of equipment.

Topic or Operation	**Related Knowledge**	**Notes**
1. Electrical Systems		
Ignition	Review of standard system	Unit replacement concept.
	Theory and operation of electronic ignition — advantages and disadvantages	
	Capacitive discharge systems	
	Servicing	Caution: — check service instructions **before** starting tests.
	Use of analyser scopes if available	
Starting Circuit Unit	Motor principle	Inertia
	Wiring diagrams	Overrunning clutch
	Types of starter drives	
	Solenoids	
	Tests	Use of growler and test lights.
	— visual inspection	
	— grounds, shorts, continuity checks	
	Servicing	
	— turn and undercut arm	
	— brushes, bushings	
	— lubrication	
Generator and Alternator Unit	Generator principle	
	Wiring diagrams for internal ground and external ground	
	Simplified regulator circuits	Use of A.V.R. tester.
	Generator out-put tests for internal and external circuits	
	Diagnose lack of generation as either faulty generator or faulty regulator	Use of jumper wire.
	Polarization of generator	
	Alternator theory	
	Overlapping windings in stator to give 3 phase	
	1/2 and full wave rectification	
	Diodes	
	Comparison of generator to alternator	Check fan belt tension.
	Alternator out-put tests	Disconnect battery before connecting meter.
	Diagnose lack of out-put tests either alternator problem or regulator problem	Use of jumper wire.
		Service data.
	Test procedures	
	— ohmmeter to check diodes	
	Brush assembly techniques	

Topic or Operation	Related Knowledge	Notes
2. Brakes	Hydraulic mechanisms	
	— Master cylinder	
	- single	Theory of operations, diagrams, visual aids.
	- dual	
	- residual pressure check valves	
	- brake warning lights	
	- service procedures	
	— Wheel cylinders and lines	Construction.
	- size of line as it relates to pressure	
	- step bore cylinders	
	- line flaring techniques	
	— Brake fluid	
	- properties	
	- emergency substitutes	
	— diagnosis of brake pedal condition	e.g. spongy due to air in system, etc.
	— power assist brakes	
	Brake shoe arrangements	
	— lockheed single and double anchor	
	— bendix duo-servo	
	— caliper disc brakes	
	— servo or self energizing action	
	- advantages	
	- disadvantages	
	— proportional valves	
	Diagnosis of brake problems	
	— grabbing	
	— pulling	
	— brake fade	
	— no pressure	
	Overhaul techniques	
	— turning drums or rotors	
	— rounding shoes	
	— lubing backing plates	
	— adjustment	
	— self adjusting mechanisms	
3. Steering Unit	Steering geometry	
	— Ackerman principle	
	Camber	
	Caster	
	King-pin inclination or steering axis inclination	
	Toe-in	
	Wheel balance	
	Tire wear	
	Steering linkages	

Topic or Operation	Related Knowledge	Notes
3. Steering Unit (cont'd)	Steering gears — manual - worm and sector - recirculating ball - rack and pinion — power - linkage type - integral type — power steering pumps	Adjustment sequence. simulation on hydraulic test bench.
4. Clutch Unit	Single dry disc operation Purpose of clutch Method of operation Throw -out bearings Causes of slip and chatter Clutch adjustment	A hydraulic press or arbour press can be used to operate an old clutch pressure plate to demonstrate the release action.
5. Transmission Unit	Manual — gear ratios — relationship between R.P.M. and Torque — power flow through 3 speed standard — synchro-mesh or cone clutches — power flow through 4 speed standard — overdrive mechanisms — speedometer drive mechanisms	Through the use of charts, models and texts, the student should become familiar with names of transmission parts and be able to follow the power flow from in-put to out-put in any gear.
	Automatic — fluid couplings — torque converters — overrunning clutches — planetary gear system — use of multiple disc clutches and brake bands to change gear ratios and rotation — shift control by selector, throttle rod, governor and vacuum modulator — adjustments, cleaning and refilling and checking fluid	Torque multiplication. Working model can be made from old set.

The aim of this unit is to have students understand the operation of automatic transmissions and become familiar with terminology. Heavy concentration on automatic transmission overhaul is not recommended as it is very difficult to teach in school shops situations.

Topic or Operation	Related Knowledge	Notes
6. Drive Line Unit	Open and closed type driveshafts	
	Ball and trunion universal joint	
	Cross and roller universal joint	Procedures for replacing U joints in driveshaft.
	Varying shaft speeds due to angle of U joint	
	Constant velocity universal joint	
7. Rear Axle Unit	Differentials — purpose — theory of operation — hypoid gears — limited slip differentials — overhaul procedures — pinion depth setting — pre-load of bearings — setting backlash — diagnosing tooth contact	Charts, cut-away models and films are very useful in teaching this often difficult concept.
	Axles — flanged and tapered types — semi-floating and full floating axles	
	— axles bearings and seals	Removal and replacement technique.
	Alternate rear axles arrangements — independant — front wheel drive — four wheel drive	
8. Emission Control Systems Unit	Crankcase ventilation and recirculation systems Fuel evaporative recirculation systems	A real effort should be made to make students aware of the ecological need for control systems.
	Techniques for obtaining leaner starting mixtures	
	Air injection systems	
	Catalytic converters	Glen's emission controls systems is a good reference for this unit.
	Engine modifications to promote cleaner burning	

ELECTRICITY/ ELECTRONICS

10. ELECTRICITY/ELECTRONICS

10.1 Preamble

It should be clearly understood by the reader that the Electricity/Electronics program differs in format in as much as the learning outcomes have been integrated with a sample outline. The Electronics program is very much related to the particular background of the individual teacher. The teacher will therefore develop his own program from the integrated learning outcomes and sample outline.

One of the main intentions in revising the Electricity/Electronics program is to suggest a change in approach. Instead of teaching the theory and then applying it in a project situation, the new approach suggests that students should first become involved with projects and other practical work. The students should then be introduced to the theoretical aspects that they need to know in order to proceed further.

10.2 Introductory Statements

10.2.1 Students learn best when they are highly motivated; that is, when they have a keen interest in what they are doing and what they expect to do. Their natural curiosity and interest provides them with the incentive to become active learners. Regardless of the grade level involved, each specific course must be structured to meet the needs of each individual student by:

- being related to the expectations of the students;
- being responsive to the various rates of progress of the students;
- being real life experiences whenever possible;
- being worthwhile and rewarding;
- being open-ended enough at a suitable level so that each student may pursue areas of particular interest;
- providing the opportunity to build or create devices that function; that is, either alter or cause sound, light or motion.
- providing ample opportunity for success.

10.2.2 It is expected that each instructor will approach the development of the courses for which he is responsible with the following philosophy in mind:

- learning should be from:
  - general to specific;
  - system to unit;
  - practical to theoretical (students starting with an interesting experience will readily learn the skills and knowledge they need to know in order to progress).

- courses should assist students to develop their ability to learn new knowledge in an expanding society.
- as technology changes it is important to review the content of the courses related to the technology.
- the skills and knowledge required for the design, construction, testing and modification of some device of a student's interest are far more meaningful than the assimilation of some abstract technological data.
- at each stage of development, a student should, by using the correct terminology, be able to discuss or explain the concepts studied and the work completed.

10.2.3 This curriculum has been arranged by first determining some general areas in which every student in the Electronics program should attain some reasonable progress. For each of these areas attainment has been indicated for the appropriate grade levels. Finally, the materials for each of the grade levels have been identified. This arrangement clearly indicates the type of work to be undertaken and the various learning outcomes that should be built into each student's experience. Note that levels 11 and 12 are not separated. This arrangement allows an instructor greater flexibility in determining his specific course.

10.3 General Objectives

10.3.1 It is intended that the specific area of work or study is first selected, then the remaining general areas of attainment be applied to the specific task selected. The exact content that students should be exposed to can then be determined. The general areas for attainment in the Electricity/Electronics course are:

- to gain experience and knowledge in the outlined areas of work and study.
- to gain some knowledge of systems, and how the functional units connect to each other.
- to design or modify a system or sub-system.
- to initiate and complete a project or practical job to a reasonable standard.
- to read drawings related to the subject area.
- to develop skills in the use of hand tools.
- to develop skills in the use and application of test equipment.
- to gain knowledge of units of measurement.
- to gather, organize, and interpret performance data.
- to gain knowledge of troubleshooting techniques and procedures.
- to develop skills in the use of reference materials and resources.

10.4
I.E. 8 - electricity - MODEL

Intended Learning Outcomes	BASIC
1. To gain experience and knowledge in the outlined area of work and study.	1. Simple electronic circuits and systems — amplifiers, oscillators — radios Simple electromagnetic circuits — bells, buzzers, relays, solenoids Minor electrical repairs
2. To gain some knowledge of systems, and how the functional units connect to each other.	2. All systems have 3 basic functional units — — power source — control circuit — load Have students connect different systems — demonstrate other systems.
3. To design or modify a system or subsystem.	3. Not essential.
4. To initiate and complete a project or practical job to reasonable standard.	4. One or more simple projects should be completed by each student. Pictorial or schematics should be the source of information. Such projects might either be breadboarded or assembled on a previously prepared circuit board. **Note:** These activities promote the personal development and creativity of each student. The work should embrace all aspects of the course.
5. To read drawings related to the subject area.	5. Elementary levels of block or system pictorial, schematics, and connection diagrams.
6. To develop skills in the use of hand tools.	6. Screwdriver, pliers, soldering pencils, other tools as required.
7. To develop skills in the use and application of test equipment.	7. How to connect and read a DC Voltmeter, Ohmeter and DC Ammeter.
8. To gain knowledge of units of measurements.	8. Volts, amperes, and ohms. Linear measurement — metre, centimetre, and millimetre.

Intended Learning Outcomes	**BASIC**
9. To gather, organize, and interpret performance data.	9. Current and voltage measurements to illustrate the ohms law relations informally (avoid formula at this time).
10. To gain knowledge of troubleshooting techniques and procedures.	10. Limited to only the problems they encounter in the projects and activities with which they are involved.
11. To gain skills in the use of reference materials and resources.	

Intended Learning Outcomes	BASIC
1. To gain experience and knowledge in the outlined areas of work and study.	1. Electronic circuits and systems — power supply (unregulated) — oscillator (siren, metronome, code practice oscillator) — amplifier — alarm circuits (light controlled, sound controlled, continuity — simple semiconductor controlled circuits (light dimmer, flasher) Electromagnetic circuits and systems — relays, solenoids, motors and generators, transformers — servicing and repairs to small electrical appliances Chemical cells — types, applications, specifications
2. To gain some knowledge of systems, and how the functional units connect to each other.	2. Build a simple system (such as power supply). What does each functional unit do in the system you use. Exchange functional units in a system — for example, inputs and outputs.
3. To design or modify a system or subsystem.	3. Minor modifications of a project under controlled circumstances.
4. To initiate and complete a project or practical job to a reasonable standard.	4. All students need not do the same project, and they should not be expected to do similar projects with the same degree of skills and workmanship or in the same length of time. At least one circuit board should be completed for designing the layout to the assembly and testing of the circuit. All completed projects should be suitably enclosed or mounted. **Note:** These activities promote the personal development and creativity of each student. The work should embrace all aspects of the course.
5. To read drawings related to the subject area.	5. A more detailed use and coordination of block or system, pictorial, schematic, and connection diagrams. Development of printed circuit board layout from schematics and connection diagrams. Use of schematics and pictorials for taking measurements.

Intended Learning Outcomes	**BASIC**
6. To develop skills in the use of hand tools.	6. Screwdriver, pliers, soldering pencil, drill, layout tools, Whitney punch and other tools as required.
7. To develop skills in the use and application of test equipment.	7. Use of V.O.M. — AC volts — DC volts, amperes, and milliamperes — ohms, kilohms and megohms Observe qualitative waveforms with an oscilloscope Observe size pattern Use of audio signal generator
8. To gain knowledge of units of measurements.	8. Current — amperes and milliamperes Pressure — DC and AC volts Resistance — ohms, kilohms, and megohms Linear measurement — metres, centimetres, and millimetres. Power — watts Frequency — hertz and kilohertz
9. To gather, organize, and interpret performance data.	9. Ohms law as a natural outcome of practial work. Quantitive measurements of AC and DC, and qualitative examination of the project variables such as ripple, gain, output.
10. To gain knowledge of troubleshooting techniques and procedures.	10. An organized approach to troubleshooting on their projects and activities making use of the systems concept. Input, output, signal path, power supply voltages, critical DC circuit voltages.
11. To gain skills in the use of reference materials and resources.	11. Obtain some specific information related directly to a current project or activity. This would require considerable direction by the instructor. Large group, small group and individual field to observe and gain knowledge of electrical or electronic applications. Use of outside resource people.

10.6
Electronics 11 and 12

Intended Learning Outcomes	BASIC
1. To gain further experience and knowledge in the outlined areas of work and study.	1. Audio systems — introduction to audio systems including types of inputs, processing and outputs. — audio system design requirements — power supply, input characteristics, output characteristics, amplifier and controls. — functional units Power supply — voltage and current requirements — filtering regulation — fusing protection Amplifier and controls — input and output impedance — gain and power output — distortion — frequency response — equalization (RIAA) — volume and tone controls — function switches Input devices — tape, phone, microphone — level and impedance Output devices — speakers and enclosures RF systems — introduction to RF systems — receivers and transmitters. — propogations of RF energy — transmission lines, antennas, electromagnetic radiation. — RF receivers — amplification, hetrodyning, intermediate frequency, demodultation, audio amplification. — RF transmitters — carrier generation, modulation, (AS, FM, SSB) — some functional units — oscillator circuits, filters, matching devices, multiplexers. — RF measurements — microvolts, watts, P.E.P. percentage of modulation, deviation, signal to noise ratio, SWR. **Note:** Consideration might be given to operating this section as a ham radio course with appropriate projects.

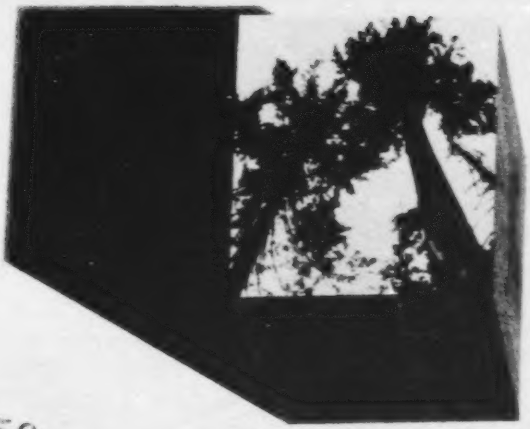
Intended Learning Outcomes	BASIC
1. To gain further experience and knowledge in the outlined areas of work and study. (cont'd)	Digital systems — introduction to digital and logic circuitry. — logic statements, truth tables, logic levels. logic symbols. logic devices — gates (and, nand, or, nor inverters), flip-flops (R-S, D type, J-K), counters, shift registers, encoders, decoders, indicators. — number systems — decimal, binary, others. — clocking systems. Electrical systems — motors and generators; DC motors and generators — series, shunt, compound, AC motors, single phase fractional horsepower, AC generators and alternators — single phase and 3 phase, universal motors. **Note:** For each of the foregoing category studies; loading, regulation, torque, and losses should be considered whenever possible. — motor and power controls — electromechanical — electronic (SCR's and Triacs). — generation, transmission, and distribution of power, power generators, residential wiring, transformers — single and 3 phase, transmission lien losses. Instructors should feel free to select additional areas of work that are pertinent to the needs of their students — meter and instrument circuits, automotive electricity and electronics, instrument servicing, communication (telephony), linear IC's.
2. To gain some knowledge of systems, and how the functional units connect to each other.	2. A detailed study, including the construction of, modifications to, and performance characteristics of at least one system for each course taken. Students taking several courses should study more than one system,
3. To design or modify a system or subsystem.	3. Solution of problems which necessitate the design and/or functional units. As an example the problem may be to design a sequence counter and the solution would involve the development of a logic system using the facilities that the shop provides.

Intended Learning Outcomes	BASIC
4. To initiate and complete a project or practical job to a reasonable standard.	4. At least one major project or practical job for each course taken. Each student should be encouraged to select a project or practical job that will challenge his/her ability. **Note:** These activities promote the personal development and creativity of each student. The work should embrace all aspects of the course.
5. To read drawings related to the subject area.	5. Students should increase their knowledge and skills with the use of the various types of electronic and electrical diagrams as they develop independence from the instructor. Diagrams students should work with are: block or system, pictorial, schematic, connection, logic, power, printed circuit layout, part layout, and other activity related diagrams.
6. To develop skills in the use of hand tools.	6. In addition to all previous tools, box and pan brake, wire strippers, chassis punches and other tools are required.
7. To develop skills in the use and application of test equipment.	7. V.O.M. — general application Electronic Voltmeter — all functions Oscilloscope — calibration — voltage measurement frequency measurement — Analyze complex waveforms RF Generator — modulated and unmodulated waveforms Transistor and Tube testers **Note:** Students should have the opportunity to use some of the optional equipment listed below: R.C. Bridge Harmonic distortion meters Frequency meter Grid dip meter Electronic switch Wattmeter Pulse Generator Sweep Generator Digital Voltmeter Dual trace oscilloscope Transistor course tracer Audio Analyzer Clamp-on Meter
8. To gain knowledge of units of measurement.	8. Current — amperes, milliamperes, and microamperes. Pressure — volts, millivolts, and microvolts with DC and AC (RMS, peak, and peak-to-peak)

Intended Learning Outcomes	BASIC
	Resistance — ohms, kilohms, and megohms Linear measurement — metres, centimetres, and millimetres. Power — watts, milliwatts, and kilowatts Frequencty — hertz, kilohertz, and megahertz Inductance — henries, millihenries and microhenries Capacitance — farads, microfarads, manofarads and picofarads Decibels Other units as required.
9. To gather, organize, and interpret performance data.	9. The sort of information gathering organizing and interpreting that the student should be able to do related to his project or job, is shown in the following categories: Gathering voltage levels — DC, AC, pulse power levels current levels resistances or impedances frequency speed phrase relationships light intensity torque distortion Organizing ratios graph — linear and logarithmic vector diagrams tables Interpreting comparison with given specifications drawing conclusions from the data
10. To gain knowledge of trouble-shooting techniques and procedures.	10. In an organized manner, the student should be able to go from a system to a functional unit and from a functional unit to a component, correct the trouble and test after corrections have been made. Diagnosis should make full use of drawings and test equipment.

Intended Learning Outcomes	BASIC
11. To gain skills in the use of reference materials and resources.	11. Use of data books, application notes, specification books, test procedures, service manuals, instruction manuals, catalogue periodicals, installation instructions, reference books as required for the content of the student's course. Continuation of the field trip concept in Grade 9/10 with the addition of work experience whenever possible. Use of outside resource people.

TECHNOLOGY



11. TECHNOLOGY 11, 12

11.1 Preamble

The Technology courses introduce a new approach to the previous Industrial Power and Industrial Science courses. Teachers are expected to develop their own particular courses bearing in mind that the learning outcomes must be covered.

11.2 Introductory Statements

The focus of technology courses should centre on the development of the students by exposure to relevant technological experiences. These courses should not be used as a vehicle to train the student in a specialized area. The courses should be designed to expose the students to problem-solving and decision-making experiences.

Technology courses can only be appreciated if the students are involved in the design process. If students are involved in the process from beginning to end, they can relate to the realities of problem-solving techniques.

The approach to Technology courses depends on the teacher's training, experience, resourcefulness, enthusiasm and general outlook.

11.3 General Objectives

11.3.1 to develop an understanding of technology and an awareness of its effects upon other areas of knowledge.

11.3.2 to nurture the students' curiosity and creative thinking abilities related to design and industrial technology.

11.3.3 to encourage the students to explore the development of industrial technology.

11.3.4 to develop safety consciousness and promote work habits essential to an industrial situation.

11.3.5 to encourage the students to understand the process of searching for explanations of natural and man-made phenomena.

11.4 Technology 11/12

Intended Learning Outcomes

Upon completion, the student should be competent and confident in the application of the following:

11.4.1 Basic

- properties and uses of wood, metals and alloys and synthetic materials.
- operation of internal and external combustion engines and appreciate the reason for their design.
- the ability to test materials and record their findings in an orderly manner.
- understand the conversion of power from mechanical to electrical, electrical to fluid, fluid to mechanical or a combination of these.
- the progress of technology from the lever to the atom.
- how to read schematic diagrams in electricity, hydraulics, or pneumatics.
- drawing hydraulic, electric, or pneumatic circuits using the appropriate symbols.
- how power is transmitted using basic machine principles, and mechanical devices.
- building a chosen project or piece of equipment.
- Adhesives, industrial coatings, and lubricants.
- Safe practices when working with tools or equipment, whether it requires lifting, manual or power skills.

11.5 Suggested Development

11.5.1 Background

The Technology committee has tried to make meaningful suggestions for Industrial Education teachers embarking on Technology courses. The courses can be as diversified as the teachers' experiences.

The Technology courses need not necessarily be completely new. There are successful Industrial Science and Industrial Power courses already being taught. It is not Intended that Technology will eliminate these courses, but in fact will enhance and possibly expand the existing offerings.

The learning outcomes not covered in the project or projects may be handled in the form of a lab. Every student in a single class may not work on all aspects of the course, but they should have the opportunity of being exposed to what is happening in other areas.

When designing and constructing projects, expertise from local business and industry can be of considerable assistance.

11.5.2 Related Course Organization

1. Power Transmission	Required Information
Fluid (Hydraulics and Pneumatics)	— Physical Laws — Mechanical Advantage — Pumps — Valves — Circuits
Mechanical	— Lever and wheel principles — Clutches — Drives — Transmission — Drive shafts and universals — Differentials — Lubrication
2. Electricity	
Chemical	— Cells — primary and secondary.
Mechanical	— Magnetism — Electro-magnetism — Controls — AC - DC Circuitry — Transformers — Motors, generators and alternators

3. Materials Testing

Wood	— Strength of materials — Design factors
Metal	— Strength of materials — Metallurgy
Plastics	— Types — Manufacturing techniques
Concrete	— Strength of materials — Design characteristics

4. Form and Function — Aesthetic and mechanical values

5. Safety — Although this is set up as a unit — it must be understood that safety precautions are to be taught and practised throught the completed course.

11.5.3 Suggested Areas for Project Selection

— Heating — Air conditioning
— Refrigeration
— Civil structural design
— Computer control
— Numerical control
— Aeronautics
— Marine engineering
— Research and experimentation
— Communications
— Transportation
— Manufacturing
— Construction
— Electrical discharge machines
— Photography
— Environment
— Agriculture
— Fishing
— Plastics
— Forestry
— Mining
— Mechanical Engineering
— Energy Conservation

Suggested Projects (Working Model or Full Scale)

— Steam engine
— Pulp and Paper mill
— Saw mill
— Derrick
— Hovercraft, glider, powered aircraft
— Wind tunnel
— Ripple tank
— Mechanical drives — right angle drives
— Log carriage — utilizing servo mechanism
— Automatic reversing table — hydraulically operated
— Numerical control unit
— Automatic form turning attachment — hydraulically operated
— Mass production forming attachment for wood turning — pneumatic operated

TECHNOLOGY 11 AND/OR TECHNOLOGY 12

MODELS

Models developed in Technology 11 and 12 will be distributed through the Provincial Industrial Education Resource Centre.